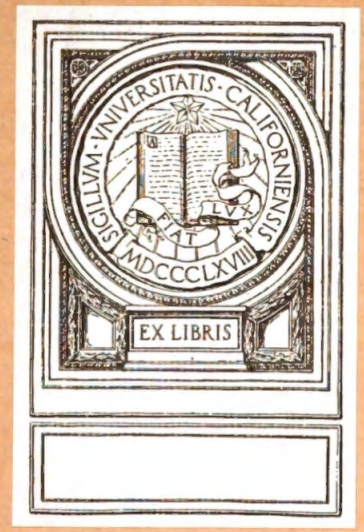
UC-NRLF
*B 413 299



Digitized by Google
Original from UNIVERSITY OF CALIFORNIA
Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

Digitized by Google
Original from
UNIVERSITY OF CALIFORNIA

National research Council
NOV 2 1921
UNIV. OF California

REPORT

OF THE

ADMINISTRATIVE CHAIRMAN

OF THE

HONORARY ADVISORY COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH OF CANADA

1917-23

For the Year ending March 31, 1918

OTTAWA
J. DE LABROQUERIE TACHÉ
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1918

Google

REPORT

OF THE

ADMINISTRATIVE CHAIRMAN

OF THE

Canada.

HONORARY ADVISORY COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH OF CANADA

For the Year ending March 31, 1918

OTTAWA
J. DE LABROQUERIE TACHÉ
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1918
43606—1

Google

UNIV. OF CALIFORNIA

LIBRARY

E7.5.

OTTAWA, 23rd May, 1918.

The Right Hon. Sir GEORGE E. FOSTER, P.C., G.C.M.G.,
Chairman of the Sub-Committee of the Privy Council for
Scientific and Industrial Research, Ottawa.

SIR,—I have the honour of presenting to you my report on the work of the Honorary Advisory Council for Scientific and Industrial Research for the year ending March 31, 1918, as required by the terms of the Act (7-8 George V, Chap. 20) constituting the Council.

I have the honour to be,

Your obedient servant,

A. B. MACALLUM,
Administrative Chairman of the Honorary Advisory Council for Scientific and Industrial Research.

43606—2

Google

TABLE OF CONTENTS.

	PAGE.
Members of the Sub-Committee of the Privy Council for Industrial and Scientific Research	3
Members of the Honorary Advisory Council for Scientific and Industrial Research	3
Members of the Standing Associate Committee on Chemistry and on Mining and Metallurgy	4
Advisory Committee for British Columbia	6
Report of the Administrative Chairman of the Honorary Advisory Council for Scientific and Industrial Research	7
Appendix A. Report of Associate Chemical Committee	33
Appendix B. List of Students and Fellows	37
Appendix C. Regulations governing the award of Studentships and Fellowships	37
Appendix D. Regulations on Assisted Researches	38
Appendix E. Report of the Committee of the Privy Council on Scientific and Industrial Research in Canada, June 6th, 1916	39

Google

THE SUB-COMMITTEE OF THE PRIVY COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH.

The Right Honourable Sir GEORGE E. FOSTER, P.C., G.C.M.G., *Minister of Trade and Commerce, Chairman.*

The Honourable ARTHUR MEIGHEN, K.C., *Minister of the Interior.*

The Honourable T. A. CRERAR, *Minister of Agriculture.*

The Honourable MARTIN BURRELL, *Secretary of State and Minister of Mines.*

The Honourable T. W. CROTHERS, K.C., *Minister of Labour.*

The Honourable ALBERT SEVIGNY, K.C., *Minister of Inland Revenue.*

THE HONORARY ADVISORY COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH.

A. B. MACALLUM, M.A., M.B., Ph.D., Sc.D., LL.D., F.R.S., Ottawa, *Administrative Chairman.*

F. D. ADAMS, Ph.D., Sc.D., LL.D., F.R.S., Dean of the Faculty of Applied Science, McGill University, Montreal.

T. BIENVENU, Esq., Vice-President and General Manager, La Banque Provinciale du Canada, Montreal.

R. HOBSON, Esq., President, Steel Company of Canada, Hamilton, Ont.

S. F. KIRKPATRICK, M.Sc., Professor of Metallurgy, Queen's University, Kingston, Ont.

J. C. MCLENNAN, Ph.D., F.R.S., Professor of Physics, and Director of the Physics Laboratory, University of Toronto, Toronto, Ont.

A. S. MACKENZIE, Ph.D., D.C.L., President, Dalhousie University, Halifax, N.S.

W. C. MURRAY, M.A., LL.D., President, University of Saskatchewan, Saskatoon, Sask.

R. A. ROSS, E.E. (Tor.), M. Can. Soc. C.E., Consulting Engineer, 80 St. Francois Xavier Street, Montreal.

R. F. RUTTAN, M.A., M.D., Sc.D., Professor of Chemistry, and Director of the Chemical Laboratories, McGill University, Montreal.

ARTHUR SURVEYER, B.A.Sc., M. Can. Soc. C.E., Consulting Engineer, 274 Beaver Hall Hill, Montreal.

J. B. CHALLIES, C.E. (Tor.), M.Can. Soc. C.E., Superintendent, Dominion Water Power Branch, Ottawa, *Secretary.*

Google

ASSOCIATE COMMITTEE IN CHEMISTRY.

DR. R. F. RUTTAN, B.A., M.D., Sc.D., Director of the Department of Chemistry, McGill University, Montreal, Que., *Chairman.*

J. W. BAIN, B.A.Sc., Professor of Chemical Engineering, University of Toronto, Toronto, Ont.

JOHN BATES, Chem. E., Ph.D., Superintendent, Forest Products Laboratories of Canada, Montreal, Que.

F. J. BIRCHARD, B.A., Ph.D., Research Chemist, Dominion Grain Laboratory, Winnipeg, Man.

Prof. ADAM CAMERON, M.A., B.Sc., Professor of Chemistry, University of New Brunswick, Fredericton, N.B.

W. H. ELLIS, M.A., M.B., LL.D., Dean of the Faculty of Applied Science, University of Toronto, Toronto, Ont.

W. L. GOODWIN, B.Sc., D.Sc., Director of the School of Mines, Kingston, Ont.

MILTON L. HERSEY, M.A.Sc., LL.D., President, Milton Hersey Limited, Consulting Chemists, Montreal, Que.

F M. G. JOHNSTON, M.Sc., Ph.D., Chemist, Curtis and Harvey, Dragon, P.Q.

A. F. L. LEHMANN, B.S.A., Ph.D., Professor of Chemistry, University of Alberta, Edmonton, Alta.

E. A. LESUEUR, B.Sc., Consulting Electrical and Chemical Engineer, Ottawa, Ont.

E. MACKAY, B.A., Ph.D., Professor of Chemistry, Dalhousie University, Halifax, N.S.

I. C. MACKIE, B.A., Chief Chemist, Dominion Steel Corporation, Sydney, N.S.

D. MCINTOSH, M.A., D.Sc., Professor of Chemistry, University of British Columbia, Vancouver, B.C.

R. D. MACLAURIN, B.A., Ph.D., Professor of Chemistry, University of Saskatchewan, Saskatoon, Sask.

H. W. MATHESON, M.Sc., Chemist and General Manager, Canadian Electro Products Co., Shawinigan, P.Q.

M. A. PARKER, B.Sc., F.C.S., Professor of Chemistry, University of Manitoba, Winnipeg, Man.

T. H. WARDLEWORTH, F.C.S., Chairman, Canadian Branch, Society of Chemical Industry, Montreal, Que.

ASSOCIATE COMMITTEE ON MINING AND METALLURGY.

F. D. ADAMS, Ph.D., Sc.D., LL.D., F.R.S., Dean of the Faculty of Applied Science, McGill University, Montreal, Que., *Chairman.*

S. F. KIRKPATRICK, M.Sc., Professor of Metallurgy, Queen's University, Kingston, Ont., *Vice-Chairman.*

Google

Major CHAS. L. CANTLEY, B.Sc., Acting Works Manager, Nova Scotia Steel and Coal Company, New Glasgow, N.S.

A. A. COLE, B.Sc., M.A., Mining Engineer, Temiskaming and Northern Ontario Railway Commission, Cobalt, Ont.

C. V. CORLESS, M.Sc., General Manager, Mond Nickel Company, Coniston, Ont.

TH. DENIS, B.Sc., Superintendent of Mines, for the Province of Quebec, Quebec, Que.

CHAS. FERGIE, Esq., President, Intercolonial Coal and Coke Company, 413 Dominion Express Building, Montreal, Que.

A. R. GLOBE, Esq., Assistant General Manager, Hollinger Gold Mines, Limited, Timmins, Ont.

GEORGE A. GUESS, M.A., Professor of Metallurgy, University of Toronto, Toronto, Ont.

J. C. GWILLIM, B.Sc., Professor of Mining Engineering, Queen's University, Kingston, Ont.

E. H. HAMILTON, B.Sc., Consulting Metallurgist to the Consolidated Mining and Smelting Company, Trail, B.C.

H. E. T. HAULTAIN, C.E., Professor of Mining Engineering, University of Toronto, Toronto, Ont.

A. MAILHIOT, B.Ap.Sc., Professor of Geology, L'Ecole Polytechnique, 228 St. Denis Street, Montreal, Que.

E. P. MATHEWSON, B.Sc., General Manager, British American Nickel Corporation, 8 King Street East, Toronto, Ont.

Lieut.-Col. D. H. MCDOUGALL, LL.D., General Manager, Dominion Steel Corporation, Sydney, N.S.

J. G. MORROW, Esq., Inspecting Engineer, Steel Company of Canada, Hamilton, Ont.

J. BONSALL PORTER, Ph.D., Sc.D., Professor of Mining Engineering, McGill University, Montreal, Que.

FRASER D. REID, B.Sc., Manager, Coniagas Mines, Limited, Cobalt, Ont.

W. FLEET ROBERTSON, B.Sc., Provincial Mineralogist, Victoria, B.C.

F. H. SEXTON, S.B., President, Nova Scotia Technical College, Halifax, N.S.

A. STANSFIELD, Sc.D., Professor of Metallurgy, McGill University, Montreal, Que.

JOHN T. STIRLING, Esq., Chief Inspector of Mines for Alberta, Edmonton, Alta.

R. H. STEWART, B.Sc., Consulting Mining Engineer, 736 Granville Street, Vancouver, B.C.

J. B. TYRRELL, B.Sc., M.A., Consulting Mining Engineer and Geologist, 534 Confederation Life Building, Toronto, Ont.

O. E. S. WHITESIDE, M.Sc., General Manager, International Coal and Coke Company, Coleman, Alta.

43606—3

Google

THE BRITISH COLUMBIA HONORARY ADVISORY COMMITTEE.

JUDSON F. CLARK, M.A., Ph. D., Forest Engineer, 420-424 Vancouver Block, Vancouver, B.C.

C. MCLEAN FRASER, M.A., Ph.D., Curator, Biological Station, Nanaimo, B.C.

R. F. HAYWARD, M. Can. Soc. C.E., General Manager, Western Canada Power Company, Vancouver, B.C.

GEORGE KIDD, Esq., General Manager, B.C. Electric Railway Company, Hastings and Carrall Sts., Vancouver, B.C.

P. H. MOORE, B.S.A., Colony Farm, (B.C. Government Farm), Essondale, B.C.

J. S. RAPHAEL, Esq., 1461 Harwood Street, Vancouver, B.C.

R. H. STEWART, Esq., Mining Engineer, 736 Granville Street, Vancouver, B.C.

CAMPBELL SWEENY, Esq., Vancouver, B.C.

JAMES J. WARREN, Esq., Manager, Consolidated Mining and Smelting Company of Canada, Trail, B.C.

L. S. KLINCK, M.S.A., Dean of the Faculty of Agriculture; Professor of Agronomy, University of British Columbia, Vancouver, B.C.

H. R. MACMILLAN, B.S.A., M.F., Forester, Imperial Munitions Board, Vancouver, B.C.

DOUGLAS MCINTOSH, M.A., Sc.D., F.R.S.C., Professor of Chemistry and Head of the Chemistry Department, University of British Columbia, Vancouver, B.C.

J. M. TURNBULL, B.A.Sc., Professor of Mining and Metallurgy, and Head of the Metallurgy Department, University of British Columbia, Vancouver, B.C.

F. F. WESBROOK, M.A., M.D., C.M., LL.D., Professor of Bacteriology, and President of the University of British Columbia, Vancouver, B.C.

Google

REPORT

OF THE

ADMINISTRATIVE CHAIRMAN

OF THE

Honorary Advisory Council for Scientific and Industrial Research.

I. GENERAL ACCOUNT OF THE WORK OF THE COUNCIL.

On June 1, 1916, there was constituted by Order in Council a Sub-Committee of the Privy Council, consisting of the Right Honourable Sir George E. Foster, K.C.M.G., Minister of Trade and Commerce (Chairman), the Honourable the Ministers of the Interior, Agriculture, Mines, Inland Revenue, and Labour, with the object of having charge of all measures to foster the scientific development of the industries of Canada, in order that during and after the present war these may be in a position to supply all Canadian needs and extend Canadian trade abroad.

Under this Sub-Committee of the Privy Council, and by its direction, an Honorary Advisory Council for Scientific and Industrial Research was constituted on the 29th of November of the same year, composed of eleven representatives of the scientific, technical, and industrial interests of Canada.

This Research Council, by the direction of the Chairman of the Sub-Committee of the Privy Council, was charged with the following duties:—

(*a*) To ascertain and tabulate the various agencies in Canada, which are now carrying on scientific and industrial research in the universities and colleges, in the various laboratories of the Government, in business organizations and industries, in scientific associations, or by private or associated investigators.

(*b*) To note and schedule the lines of research or investigation that are being pursued by each such agency, their facilities and equipment therefor, the possibilities of extension, and, particularly, to ascertain the scientific man-power available for research and the necessity of adding thereto.

(*c*) To co-ordinate these agencies so as to prevent overlapping of effort, to induce co-operation and team work, and to bring up a community of interest, knowledge, and mutual helpfulness between each other.

(*d*) To make themselves acquainted with the problems of a technical and scientific nature that are met with by our productive and industrial interests, and to bring them into contact with the proper research agencies for solving these problems, and thus link up the resources of science with the labour and capital employed in production so as to bring about the best possible economic results.

43606—3½

Google

(*e*) To make a scientific study of our common unused resources, the waste and by-products of our farms, forests, fisheries and industries, with a view to their utilization in new or subsidiary processes of manufacture and thus contributing to the wealth and employment of our people.

(*f*) To study the ways and means by which the present small number of competent and trained research men can be added to from the students and graduates of science in our universities and colleges, and to bring about in the common interest a more complete co-operation between the industrial and productive interests of the country and the teaching centres and forces of science and research.

(*g*) To inform and stimulate the public mind in regard to the importance and utility of applying the results of scientific and industrial research to the process of production by means of addresses to business and industrial bodies, by the publication of bulletins and monographs, and such other methods as may seem advisable.

The Meetings of the Council.—The first meeting of this Research Council was held in Ottawa on December 4-6, 1916, the sessions of which were chiefly devoted to organization and the formulation of the lines of action along which the Council should proceed to carry on its functions. At this meeting it was decided to recommend to the Sub-Committee of the Privy Council the appointment of an Administrative Chairman who should give his time wholly to the duties of the position. This recommendation was, before the end of the meeting, given effect by Order in Council, by the appointment of the present Chairman.

Since the inception of the Council, twelve meetings in all have been held, and monthly, with the exception of July and August, during which the Administrative Chairman and three members were absent on a visit to the western provinces for the purpose of consulting various Boards of Trade and Technical Organizations on the subject of the development of the industries of Western Canada. The great majority of these meetings covered three days of continued sessions, but the work done by the members was not confined to the occasions of the meetings, for all were more or less engaged, in some cases continuously, in the intervals, on the questions brought forward at the meetings, and some of the members, acting as chairmen of committees of the Council, have attended assiduously to the duties which their position involved.

Research Council Act.—The interest which the members of the Council have manifested in the service they are enthusiastically rendering has been given an enduring character through the establishment of the Council as a permanent organization by the Act which received vice-regal assent on August 29, 1917, and which gives to the Council, under the supervision of the Sub-Committee of the Privy Council powers and responsibilities, the wise exercise of which must greatly enhance its usefulness.

Expenditures of Council.—The expenditure of the Council during the first four months, ending March 31, 1917, of its existence was met out of the vote to the Department of Trade and Commerce for the development of Canadian trade. For the last year the expenditures have been met out of the parliamentary grant of $91,600 to the Council, but only $50,374.65 was disbursed, since, as the grant was given in the Supplementary Estimates, it was available only during the last six months of the year and, in consequence, only a half of what was in the programme for the year could be appropriated and expended for definite projects within the financial year.

Assisted Researches.—There were many applications for assistance for special researches in the industrial as well as in the scientific field, which could not be granted, primarily because the total of the amounts asked for exceeded by three times the amount the Council had at its disposal for this purpose. Further, the task of sifting out those which appeared to be deserving of assistance was not, in every case, an easy

one. Care was exercised that the projected research for which a grant should be made should be capable of being brought to a successful conclusion. This made it necessary to examine and carefully consider each case, and, accordingly, a number of them have been approved and granted the assistance applied for. Several of these, however, have not been undertaken because of the difficulty involved in finding the investigators required for carrying them out, while two others could not be followed up owing to the impossibility of obtaining the apparatus or the mechanical outfits required for undertaking them. This is what may be expected. Problems cannot be solved in time limits. A grant to aid in research, therefore, should not involve a time penalty, and, hence, researches begun in one year may extend beyond the year in which the grants given to assist them are made.

A list of the grants which have so far been made, with an account of the nature of the researches involved and the progress achieved in each problem, is given in Section V.

All the problems are of industrial interest and some of them are of very special importance. Several of these may be singled out for mention here. The results of the research on tar fog can be, and doubtless will be, applied to plants in Canada engaged in the destructive distillation of coal, wood, the liquid products resulting from the manufacture of producer gas, etc., as the cost of installation of the necessary outfit and of power is low and the action is effective. The straw gas research involves the practical utilization for heat and light on the farms of the Prairie Provinces of the enormous quantities of straw, estimated at 20,000,000 tons, now burnt to dispose of it. The results of fog signalling experiments forecast a new type of sirens for use in the River St. Lawrence and in the Gulf, and accordingly contributing to the safety of navigation therein. The studies on the composition of sulphite liquor waste of our Canadian pulp mills, enormous in quantity and poured into streams and rivers, poisoning all fish life therein, gave results which seem to point the way to the commercial utilization of at least the sugars they contain, to furnish alcohol for industrial purposes. The necessity for investigations on the production of a rust-resisting wheat is found in the fact that in one year as much as $19,000,000 were lost through the occurrence of the rust disease in Manitoba, Saskatchewan, and Alberta.

Studentships and Fellowships.—To increase the number of investigators in science who may be induced to follow a career as such in connection with the Canadian industries, the Council established twenty-five studentships and fellowships to be awarded to young graduates of our Universities and Technical Colleges, who have given evidence of the possession of the special knowledge and capacity required for the conduct on their part of independent research in some department of Science, which bears on industrial processes. Owing to the depletion of the student ranks in our Universities, which has been going on for the last three years, the number of such graduates has been very small, and, in consequence, only seven were found qualified for appointment, three to fellowships and four to studentships, all of whom are now engaged in research, each on a different problem, under the supervision of the professor or director of a laboratory in one of four different Universities. (Appendix B.) The Council hopes to increase the number of appointees for the year now commencing.

The institution of these studentships and fellowships, it may be pointed out, is in accord with one of the recommendations of the report of a British Committee, of which Sir J. J. Thomson was chairman, appointed by the Prime Minister in August, 1916, which urges that "concerted efforts should be made by employers, local education authorities, and the State, to increase the flow of capable students to the Universities and higher Technical Institutions, with a view to securing the larger supply of trained scientific workers required for industrial and other purposes."

Associate Committees.—In order that the Council may have the assistance of the best expert advice along a number of technical lines, it appointed several committees, composed of a number of leading specialists, to whom may be referred, as the occasion may require, questions and problems in the solution of which the wide experience and technical knowledge of each such committee may be of very great service. Three of these are permanent organizations: the Associate Chemical Committee, the Associate Committee on Mining and Metallurgy, and the Associate Committee on Forestry. It has been arranged that the chairman of each shall be a member of the Council, in order that its work will be in intimate relation to that of the latter. It is contemplated that other such committees will be appointed as the need for them develops.

Associate Committee on Chemistry.—The report of the Associate Committee on Chemistry (Appendix A) gives a summary account of its activities during the first seven months of its existence and indicates the character of the questions which were referred to it. A number of these were advanced in the answers given in questionnaire No. 3 issued to the industries (*vide* Section III) for the purpose of ascertaining the extent of their equipment for industrial research and their problems involving scientific and technical processes of importance to their development. Each problem was carefully considered and a report thereon, embodying the best expert information on the subject, was furnished to the Firm or Company which advanced the problem.

Associate Committee on Mining and Metallurgy.—The Committee on Mining and Metallurgy had a smaller number of problems, chiefly from the answers to questionnaire No. 3, to consider and report on, and they were dealt with in the same way. The committee, under the call of the chairman, Dr. F. D. Adams, held a meeting in Montreal on March 5 and 6, at which there was an attendance of seventeen members, and during its sessions the whole subject of Mining and Metallurgy in Canada was passed under review. Several proposals were advanced concerning the utilization of ore and fuel deposits in various parts of the Dominion, which were referred to appropriate special committees to be reported on to the Research Council. It is proposed to hold meetings of this committee at regular intervals in order to concentrate attention upon the development of our mineral resources.

Temporary Committees.—Temporary committees, composed chiefly of members not otherwise associated with the Council, have been appointed to deal with the following subjects:—

Flax Cultivation in Canada. (Prof. Ruttan, Chairman).

Cold Storage Research. (Prof. E. E. Prince, Chairman).

The Fraser River Salmon Question (in conjunction with the Biological Board of Canada).

Plant and Animal Diseases.

Underground Waters for the Western Plains.

Flax Cultivation.—The Committee on Flax Cultivation in Canada, consisting of Professor Ruttan, Mr. J. H. Grisdale, Director of the Central Experimental Farm, Mr. Ferd. Van Bruyssel, and the Administrative Chairman, appointed in view of the decrease in flax cultivation in Russia, Holland, and Belgian because of war conditions, and the consequent deficiency in the supply of linen and twine, had the assistance of Mr. Stewart Cox, representatives of the Fibre Corporation, of London, sent to Canada to report on the possibilities of increased cultivation of flax for the manufacture of linen required for the construction of aeroplanes. It recommended that every effort be made to increase the acreage for 1918 of the flax grown in Eastern Canada. Mr. Grisdale was asked to represent the urgency of this step to the Flax Growers' Association, a meeting of which took place in March. Mr. Grisdale reports that the acreage sown in 1918 may be 14,000, as compared with 8,000 sown last year, but this depends on the availability of the seed and the labour required. The crop of 1917 has not all been worked up

owing to scarcity of the labour skilled in scutching. The flax of Saskatchewan and Alberta, from about 800,000 acres, has been produced for seed only, and cut instead of pulled, the straw of which was disposed of by burning it, as, owing to the character of the stalks and to climatic conditions, which make "retting" on the Western Plains practically impossible, it could hitherto not be economically utilized. Efforts are, however, now being made to use this straw for making fibre for cordage and twine, efforts which are deserving of attention in view of the scarcity of linen fibre now in such demand everywhere.

Cold Storage Research.—The Cold Storage Research Committee, composed of Prof. E. E. Prince; Mr. J. A. Ruddick, dairy and cold storage commissioner; and Dr. F. T. Shutt, associated with the British Cold Storage Board, is engaged in gathering all the information bearing on the use of methods of refrigeration in connection with the storage and transportation of fish, meat, fruit, etc. Two bulletins, to be published shortly—one on the proper utilization by consumers of cold storage products; the other on the right application of refrigeration for the preservation of fish—are the first products of its activities.

The Fraser River Salmon Question.—The committee on the Fraser River Salmon Question was appointed to consider the measures to be taken to preserve the supply of sockeye salmon, the first amongst the more important fishes of British Columbia waters. Urgent representations were made to the Research Council by the British Columbia Canners' Association and other organizations in that Province concerned in the fish industry, to the effect that, owing to reckless and even criminal overfishing of it in its course in international waters in the strait of Juan de Fuca and to the mouth of the Fraser river, to ascend to its spawning beds in the upper reaches of that river, it was in danger of extinction and that immediate action would be necessary to prevent this. From fifteen to ten years ago efforts were made to bring about an agreement between the authorities of the State of Washington and the Canadian Government to limit the number and use of seines, nets, traps, and other contrivances employed to catch the sockeye in its course to the spawning grounds, but influences, under the guise of State rights, made these efforts ineffective. The question became an acute one last year, owing to the failure in the run of the sockeye, and, in consequence, all parties on the north and the south of the boundary line in that locality were ready for arranging an agreement as to the measures to be taken to ward off the threatened danger.

The committee, consisting of Professors F. D. Adams, A. P. Knight, J. Playfair McMurrich, and R. F. Ruttan, and the Administrative Chairman, gave careful attention to the question, and it was found, as results of its inquiry:—

1. That the sockeye salmon, unless appropriate measures are taken to prevent it, is in danger of extinction as a food fish in the waters of southern British Columbia.

2. That this danger is due chiefly to overfishing with traps, seines, and nets so numerous that only a very small proportion of the fish reach the mouth of the Fraser River to spawn in its waters.

3. That an agreement to limit this fishing would have to be in the form of a treaty between the United States and Canada, in order that the forces and influences may be set aside, which might imperil continuity of operation of the proper measures to be taken to obviate the danger, a continuity that is absolutely necessary if the end sought is to be attained.

The committee reported that such an international agreement should be sought, the main provision in which would be an International Commission empowered to exercise untrammelled jurisdiction regarding the fishing, not only in the international waters in which the overfishing occurs, but also in the Fraser River, to the upper reaches of the same.

Google

The Council, after full consideration of this report, recommended that negotiations for such an international agreement be undertaken at the earliest possible date.

The council has provided for the publication of the report of the committee, as one of the series of reports which are being issued for general distribution.

Plant and Animal Diseases.—The Committee on Plant and Animal Diseases, of which Dr. W. C. Murray, President of the University of Saskatchewan, is chairman, has concerned itself with investigations on swamp fever of horses in the Prairie Provinces, and on wheat rust which has caused enormous financial losses in the West.

In close co-operation with Dr. Torrance, Veterinary Director General of the Department of Agriculture, the work on swamp fever was carried out by Dr. S. Hadwen, biologist, and Dr. Cameron, entomologist, of that department, at the University at Saskatoon during the season of 1917, and they found that the disease is much more prevalent in Saskatchewan than they had previously supposed it to be, and that the losses which the farmers experienced because of it constituted it a serious problem to them. It is proposed to continue this investigation during the coming summer with the hope of reaching results which will enable the agricultural authorities in the West to combat this evil.

Wheat rust was the subject of a conference, held August 16 to 18, 1917, between representatives of the Dominion Department of Agriculture and the Universities and Agricultural Colleges of Manitoba, Saskatchewan, and Alberta. This conference recommended that, under the leadership and responsibility of the Dominion Department of Agriculture, investigations in plant pathology, more particularly on wheat rust, be instituted and carried on in the Agricultural Colleges of the Prairie Provinces. These should each provide a greenhouse, laboratory, and office accommodation, with free light, heat, and water, and a plot of land for experimental purposes, all to be under the direction of a plant pathologist, whose salary and the expenses of his laboratory assistance and equipment should be met by the Dominion. The plant pathologist, it was also recommended should be permitted by the Dominion Department of Agriculture, to give lectures, not exceeding two a week, with necessary laboratory work, on such terms as may be agreed upon by the Colleges and appointee.

The conference gave attention to the question of the part played by the common barberry (*Berberis vulgaris*) as a host in the propogation of wheat rust, and it resolved to recommend to the Ministers of Agriculture of the provinces of Saskatchewan and Alberta, that steps should be taken to eradicate this shrub and its varieties, as has been done by the Province of Manitoba and the States of Minnesota and North Dakota.

This conference recommended also that investigational work for the determining of methods of crop and soil management best suited to lessen the damage from rust be instituted by the Dominion Department of Agriculture on each of its branch Farms and Stations in the Prairie Provinces, and by the Universities, Agricultural Colleges, and Schools in the same.

Council Committees.—In order to economize the time of the Council as a whole, and to obtain expert reports on industrial questions for its action, it has appointed from its membership a large number of committees to deal with individual industrial problems, such as:—

Hydro-power Development.
Potash and Phosphates.
Nitrogen Fixation.
After-the-war use of Munition Plants.
The Utilization of the Lignites of the Western Plains.
Industrial Power.
Co-ordination of the Technical Societies of Canada.
Land Classification and Soil Survey.

The British Columbia Advisory Committee.—Though the Council was not constituted with the view of representing territorially the different parts of the Dominion, its membership includes residents of all parts of Canada except the extreme west. The difficulties that distance imposes determined this exception. A member resident in British Columbia, who could not attend at least the majority of the meetings of the Council, would not be in a position to give much assistance to the Council in its efforts to promote the interests of that province on its technical and industrial side. Were he to attend ten meetings, each of which would involve twelve or thirteen days' absence from home, he would spend thereby in each year over four months, five-sixths of which time would be given to the railway travelling, a sacrifice he should not be expected to make. It was inevitable, therefore, for at least the present and the immediate future, that British Columbia should be unrepresented on its technical and industrial side in the Council. Its interests in mining and metallurgy, forestry, fisheries, and agriculture are, however, of such national importance that sustained attention to their development is a duty of the first order, and, accordingly, the Council gave early consideration to the subject.

The wishes of those concerned in the leading industries of British Columbia had first to be considered. To ascertain them a deputation of the Council, consisting of the Chairman, Professors Adams and Ruttan, and President Murray, appointed to visit the Western Provinces with the object of investigating and reporting on their needs in relation to the functions of the Council, interviewed various Boards of Trade and representatives of the more important industries of British Columbia. The deputation, on its return in September, reported to the Council the opinion, practically unanimous in that province, that a local representative committee should be created with the function of considering all matters affecting the scientific development of the industries of British Columbia and reporting recommendations for action thereon to the Council. This committee, it was suggested by the Boards of Trade, should be nominated by the Council after a survey of all the interests which could be promoted by such a committee, and the number of members and the regulations governing its activities were to be determined by the Council.

The Council, after a careful consideration of this report, decided that such an advisory committee be created and that the membership should be fifteen, of whom five should be directly appointed by the Council after the remaining ten had been nominated, five each by the Board of Governors of the University of British Columbia and the Council of the Joint Technical Organizations of the Province. These have made their nominations, the Council has made its five appointments, and, in consequence, the advisory committee as now constituted will shortly organize for the performance of its functions. It will constantly keep under survey the industries of the Province and report its recommendations, as they are agreed upon, to the Council for action thereon. The Council believes that this advisory committee will be of great service in assisting it to give appropriate attention to the needs of British Columbia as regards industrial development.

The advisability of constituting advisory committees for certain other portions of the Dominion has been under consideration, but, as the need for such is not so pressing as in the case of British Columbia, no action has been taken, but, should urgency develop in connection with any of these, a decision thereon will not be delayed.

Promotion of Research in Canada.—The Council has had under consideration for the last nine months the question of the organizations which should be created and the methods to be adopted, by the aid of which Canadian industries may be assisted to develop by the application to them of the most advanced scientific processes, and thereby enabled not only to meet the needs of the home markets but also to compete with their rivals abroad. This question is one of paramount importance to Canada, in view of the intensified application of science to industry, which elsewhere will be fostered after the war by the State and also through private enterprise. Through the answers given in questionnaire No. 3, addressed to the industries, it has been ascer-

tained that not 2 per cent of the Firms have research laboratories and only about 10 per cent have routine laboratories, chiefly for the elementary testing of materials.

The situation indicated and the problems involved are discussed in detail in Section IV. *To meet the one and solve the other the establishment, at Ottawa or some other centre, of a research institute having the functions of the Bureau of Standards at Washington or of the National Physical Laboratory of Great Britain, is advocated. Attached to the Institute, it is suggested, should be laboratories that may be at the disposal of Guilds or Associations for Research which may be founded by the various Canadian industries, each in its own line, the Firms or Companies of which are unable individually to undertake experimental investigations with the object of improving their manufacturing processes.*

Special Problems, Lignites and Forestry Studies.—Amongst the special problems which early engaged the attention of the Council were the briquetting of lignites to form domestic fuel and the measures to be taken to preserve our forest wealth. The action taken towards a solution of both is indicated in Section II (*a*) and (*b*).

The importance of the lignite question may be indicated in a few sentences. The Provinces of Manitoba and Saskatchewan import annually from Pennsylvania about half a million tons of anthracite for domestic fuel, and send out of the country therefor more than $4,000,000. There are in these provinces, it is estimated, about 57 billions of tons of lignites, of a poor grade, largely disqualified from serving as domestic fuel. It has been shown on a super-laboratory scale, however, that they can be carbonized and briquetted and that the briquetted product is an equivalent of anthracite. There remained only the demonstration on a commercial scale of this carbonizing-briquetting process, to prove that a substitute for anthracite could be so produced, which would be cheaper in that market than anthracite, and the Council proposed that the Government should undertake to erect (and operate) at some point in southern Saskatchewan a plant to turn out 30,000 tons of this fuel yearly, the cost of which, it is estimated, would not probably exceed $7 per ton. The success of this demonstration would be far-reaching in its effect on the fuel situation in the West.

Research Inventory.—In compliance with one of the duties required of the Council, by the Order in Council establishing it, it endeavoured to make a survey of the present situation as regards research, and the equipment and man-power for the same, in Canada. Questionaires were addressed to all the Universities, Technical Institutions and Societies, Government Departments, and to several thousand industrial firms and organizations, with a view to eliciting the information required. The return of them is not yet quite complete, and, therefore, a final summary of the data required is not at present possible, but enough has been gathered from those received to furnish an indication of the present status of scientific research in Canada (*vide* Section III).

Affiliation with British Advisory Council.—The Research Council has been kept in touch with the work done during the last ten months by the British Research Council, through the attendance at the meetings of the latter of Prof. J. C. McLennan, F.R.S., as assessor and representative of the Canadian Research Council.

Professor McLennan has been assiduous in performing the duties this position calls for and also in attending meetings of the various committees at which industrial problems of interest to Canada were discussed, and, in consequence, the Research Council has the benefit of the views of our British Scientific and Technical confrères on these matters.

II. SPECIAL PROBLEMS.

(a) *The Briquetting of Lignites.*

At the first meeting of the Council, a committee consisting of Mr. R. A. Ross (chairman), and Drs. Adams, Mackenzie, and Murray, was appointed to review and report on the question of the utilization of the lignites of Western Canada for domestic fuel. The urgency of the fuel situation at the time prompted this, which urgency has since been accentuated.

What the urgency was and is now, is so well recognized that it does not require to be explained here. What contributed, and will contribute, to the urgency, and what measures other than temporary which may be taken to meet it, are less generally recognized, and they may, accordingly, be referred to, somewhat briefly.

The output for 1916 of the coal mines of the United States was approximately 550 millions of tons. The demand for coal in 1917 was in excess of the output for 1916 by 100 millions of tons, a demand which could not be met, although it was hoped to increase that output by 50 millions of tons. There was, therefore, a shortage of supply, of which Canada, as part of the market for American coal, experienced the effects.

The coal imported into Canada is distributed in the provinces of Quebec, Ontario, Manitoba, and Saskatchewan. The amount involved in 1916 was 17,551,116, of which 4,570,284 were of anthracite. Ontario and Quebec were supplied from this source practically alone, they taking in that year 14,671,239 tons, of which 4,037,284 were of anthracite. The prospective coal famine of 1917 in Canada chiefly affected these Provinces, and they could not look to Canadian sources of coal, for the output of the Nova Scotia mines was not, and could not be materially increased, and that of the Western Provinces was practically excluded from Central Canada because of the long haulage and the lack of transportation facilities. This makes, and will make, as far as one can forecast, for many years ahead, the two Central Provinces dependent on the United States for the coal they need and, consequently, any decrease in the supply from that source will be a matter of grave concern to Canada.

A part of the imported supply also goes to Manitoba and Saskatchewan, the former Province receiving in 1916, 1,952,998 tons, of which 325,000 were anthracite, and the latter 926,879, of which 208,000 were anthracite. Of western coal, almost wholly lignites and bituminous in character, Manitoba used in that year only 98,629 tons, and Saskatchewan 1,302,926. *The two Provinces, therefore, consumed 533,000 tons of anthracite imported from Pennsylvania,* nearly one-eighth of the total quantity of anthracite imported into Canada in that year.

If the coal output of the mines of the Eastern United States should be reduced, or if it should remain stationary, the needs of the home market would be paramount, and there would be a diminished supply for Ontario and Quebec, which require annually about 4,000,000 tons of anthracite, used chiefly for domestic fuel. The diminution in the supply of this in 1917 was due, in part, to war conditions, but it is doubtful if the annual output of the anthracite mines of the United States can go on increasing as it has been during the last fifty years, without reaching very shortly a figure which would predicate their exhaustion in less than a century, a possibility which has already been discussed by American authorities[1] on this subject, and it has been urged by several of them that an embargo should be placed on the exportation of anthracite, which, they hold, should be reserved for the American people alone. It is, indeed, not at all improbable that a limitation on export of anthracite may be determined upon at any time in the next few years, a decision which would seriously affect the fuel

[1] Eliot Jones: "The Anthracite Coal Combination in the United States." The Harvard University Press, 1914. The data on which the calculation is made as to how long the anthracite supply will last is given on pp. 110-113. The answer is 115 years.

Google

situation in Central Canada which, for reasons already referred to, must depend on the United States for its coal supply. The risk of a shortage to Ontario and Quebec would be more or less remote if all the anthracite exported to Canada were limited in its distribution to those provinces. In that case the half of a million tons annually required for supplying Manitoba and Saskatchewan, if replaced by a satisfactory substitute to be provided for those provinces, would equate the possible shortage of anthracite supply and permit Ontario and Quebec to receive the quantity of hard coal they require from the amount available from Pennsylvania.

The source of this substitute would be in the West itself. There is a very limited supply of anthracite at Bankhead, near Banff, Alberta, which is in a more or less comminuted condition when mined, and a considerable portion to be used as a domestic fuel, has to be briquetted[1]. Of this, only about 142,985 tons were marketed in 1916, almost wholly in Alberta and Saskatchewan. Coal of this class occurs in large quantities in the Brazeau District south of Jasper Park. Extensive deposits of anthracite obtain north of Hazelton in northern British Columbia, but certain difficulties in working them, and the very long haulage, with consequently high transportation charges, will practically exclude the mined product from districts east of Alberta. There are extensive deposits of very good bituminous coal in the Crow's Nest district, but it has not found favour in Saskatchewan and Manitoba as a domestic fuel as compared with imported anthracite, as witness the half millions tons of the latter supplied to these two Provinces at a price per ton at least 30 per cent greater than that charged in the same area for Crow's Nest coal.

The substitute, therefore, is not economically available from nature's original product in the West. It may, however, be manufactured artificially and from lignites so abundant in the West and constituting at least 70 per cent of Canada's fuel resources—that is, 12 per cent of the world's supply of fuel[2].

The utilization of these lignites, because of their vast extent and availability, as a source of power and heat for domestic use, is for the present a question of prime importance for Western Canada, and, ultimately, it may be for the whole of Canada. The better grades of them can be used for the production of power, and even the poorer varieties have been, and are being, used for this purpose.

For heating, however, they, and especially the poorer varieties of them, are largely disqualified, for the following reasons:—

1. They contain an amount of water ranging in the various grades from 20 to 40 per cent, and its evaporation on combustion in the fire-box entails the dissipation and loss of a large quantity of the heat produced.

2. They, after being mined and exposed to the air for some weeks, lose this water by evaporation, and, in consequence, they are "slacked"—that is, reduced to a powdery form—which makes their use, in domestic furnaces of the common type, difficult and disagreeable.

3. They do not, in the unslacked form, "stand up" in the fire, and are quickly consumed, this character necessitating frequent stoking. They cannot, also, in consequence, be converted into coke.

4. On combustion in the domestic furnace the heavy condensation products of the smoke, abundant in quantity, obstruct the flues and cover the hot water or steam pipes; this making necessary very frequent and tedious cleaning operations.

5. In transportation in the recently mined form the charge for what corresponds to the water content influences considerably their market price.

[1] All the so-called anthracite of Western Canada belongs to the "semi-anthracite" class.

[2] The magnitude of this supply may be gathered from the fact that the coal supply of the Maritime Provinces is only 2 per cent of the total of Canada's coal. The lignites of Western Canada are, therefore, at least 35 times the quantity of the eastern coal deposits. The proportions of the coal supply of the world, by countries, are, in percentages, as follows: United States 51, Canada 17, China 12, Great Britain 2·4, Australia 2·2, and Germany 5·4.

6. The heat value is low, as a pound of lignites of the different grades gives in British thermal units a range of 6,500 to 8,500, whereas the B.T.U.'s of anthracite are 11,500 to 13,200, and for bituminous coals from various sources, 9,000 to 14,800.

The question of briquetting these lignites has often been advanced, and various proposals have been made with that object in view. The briquetting processes are not readily directly applicable to them, and, especially, to the poorer grades such as obtain in Saskatchewan. Their bituminous content is low—on the average not more than 1 per cent.—and, unlike the German and Austrian lignites, which are rich in tarry matters, they require for briquetting an addition of pitch which will make the content of the latter at least 6 per cent. It is, indeed, possible to briquette them without the addition of any binder, but the briquettes so made do not resist disintegration under ordinary weather conditions.

Briquettes made from lignites, with the addition of a binder, are not a substitute for anthracite, and could only, at best, serve as a semi-bituminous coal with a B.T.U. value of 8,000 to 10,000. The product would have nearly all the disqualifications of the raw lignites. An equivalent for anthracite cannot be made from them simply by briquetting them.

The way of producing such an equivalent from them was indicated in part by the experiments of S. M. Darling, carried out at Estevan in 1913-14 in an investigation conducted by him for the Government of Saskatchewan, and in part by those of Prof. E. J. Babcock, Dean of the School of Mines for North Dakota, conducted at Hebron, N.D., for the State Government. These experiments were made on a semi-commercial scale, and the results were of such a character as to attract attention.

The committee of the Council, in view of the importance of the subject, as indicated in the foregoing pages, applied itself to a very thorough study of all aspects of the problem, reviewing for this purpose all the literature bearing on it, published by, or in the possession of, the various departments of the Dominion Government, and also that published by the National Government of the United States as well as by various State Governments. It also availed itself, through the good offices of the Department of Mines and of the Conservation Commission, of the services of Mr. B. F. Haanel and Mr. W. J. Dick, respectively, who assisted the committee in gathering the information necessary, and to whom the Council now extends its cordial thanks for the service they thus rendered.

The results of the investigations made by the committee were formulated in a report presented to the Council at its meeting on June 8-9, 1917, which report was, after full consideration of it, adopted by the Council and recommended for action thereon, to the Sub-Committee of the Privy Council for Scientific and Industrial Research.

The findings and conclusions of this report[1] may be summarized, as follows:—

1. The lignites, even the poorest, of the Western Plains, can be carbonized at a low temperature and give a fixed carbon residue of between 40 and 50 per cent. This residue can be briquetted, using for this purpose a binder of tar, or of sulphite pitch.

2. The processes involved have already been carried out on a super-laboratory scale, and their feasibility on an industrial scale remains only to be demonstrated.

3. From every two tons of poor lignites thus carbonized enough fixed carbon may be obtained, which, with a binder can be briquetted to furnish, approximately, one ton of fuel practically equivalent to anthracite in its heat value.

[1] This report is now being published for general distribution as the first of a series which the Research Council will issue.

Google

4. The cost per ton of the briquettes so made would not exceed $7, with a plant equipped for turning out 30,000 tons a year, allowing for war-standard prices in the material used in its construction, in its equipment and operation, allowing also for its amortization, for interest on its cost and for a fair price for the raw lignites.

5. In estimating this cost, the value of the by-products, such as gas (10,000 cubic feet per ton of lignites), ammoniacal liquor (from which ammonium sulphate, a fertilizer, can be made), and tar, was completely disregarded.

6. With this cost per ton at the plant, assuming the latter situated at or near a central railway point in Southern Saskatchewan, for example, Estevan, and with a transportation charge of $1.50 per ton to Moosejaw, and the dealers' profit and delivery cost of $1.50 more, the retail price in that city should not exceed $10 per ton, accordingly less at Regina, and at Winnipeg $11 per ton. prices that would compare extremely favourably with the prices that have prevailed and do prevail for anthracite at these points.

7. The estimated cost of the plant and of its operation for one year, including charges for amortization, interest on the expenditure of construction for one year, repairs, etc., would approximate $400,000, a sum that would be beyond the enterprise of private capital for what should initially be undertaken by the Government as a public utility.

8. The demonstration of the commercial feasibility of this carbonizing briquetting process should be made on poor lignites, such as those of Southern Saskatchewan, in order that when this is shown to be successful these processes could, without further experimentation, be applied to the better lignites of Alberta.

The Council recommended that the Government should provide the sum required to undertake this demonstration, which should be conducted by a Board of Management constituted of business and technical men entrusted with the construction and operation of the plant required for this project, which would look after the details of the marketing, under the best business conditions, of the output of the plant.

Action was not immediately taken on this recommendation, and in July and August last the Administrative Chairman, with the approval of Sir George E. Foster, Chairman of the Sub-committee of the Privy Council for Scientific and Industrial Research, entered into negotiations with the Governments of Manitoba and Saskatchewan, with the object of inducing them to provide a portion of the total amount required. The reception accorded this proposal was a favourable one and on this basis an arrangement is now being negotiated whereby the three Governments will undertake jointly to provide the sum necessary for the project, and whereby the latter may be carried out under the best business and expert conditions.

The success of this project is to be fraught with results which are to be of more importance than the immediate object of it. It will induce private capital to go into this enterprise, and eventually several plants may be erected which will supply the half a million tons that will be required to replace the anthracite hitherto imported into Manitoba and Saskatchewan from Pennsylvania, thus retaining in the country about five millions of dollars, now annually spent abroad for the supply of this fuel. It will blaze the path for the utilization not only of the *57 billions of tons of lignites of Saskatchewan,* but also of the vastly greater quantity of the better grade of this fuel in Alberta. It will inevitably lead, eventually, to a process of utilization of the vast quantities of the by-products which result, by-products which now are not highly

[1] Anthracte gives, on the average, 12,000 B.T.U.'s and the briquetted product would have, it is estimated 11,700 units. The latter would be more efficient since all its energy would, through complete combustion, be obtained as heat, whereas with anthracite a portion of the fixed carbon always escapes in the cinders.

valued but in the years to come will be the raw materials of great and flourishing industries. Finally, it will constitute the first step in the systematic, scientific utilization of the vast stores of energy locked up in the lignites of the two provinces, which are, unlike the other Provinces of the Dominion, scantily supplied with water-power.

(b) Forestry Studies.

In a memorandum of January 13, 1917, prepared for Mr. R. H. Campbell, Director of the Forestry Branch of the Department of the Interior, by the Advisory Board of the Branch, it was urged that the forestry situation in Canada, especially in the East, was such that the exhaustion in the near future of our resources in that line could not be regarded as a negligible prospect and that the measures necessary to meet this danger ought to be taken at the earliest possible date.

It was pointed out that these measures must be founded on definite information, which has not yet been ascertained, regarding the rate of reproduction and growth of Canadian forest trees, especially those of the commercial species, and also regarding the available supply of sawlog and pulpwood material. It was this lack of information that has led Governments and private concerns to treat their forest areas and limits as if they were mines instead of crops, in place of managing them for a constantly sustained yield. With this attitude was associated a disregard of waste in milling and logging, which, it was conjectured, amounts in the average to 65 per cent of the tree as it stands in the forest.

The ascertainment at an early date of all this information, the memorandum further pointed out, is imperatively necessary, for the exhaustion of the virgin supplies is drawing near and at the present moment Canada's timber wealth could not supply the present sawmill capacity of the United States for more than twenty years.

The extent of the forest supplies of the Dominion is now engaging the attention of the Conservation Commission and data on this subject, regarding British Columbia and Nova Scotia, have already been obtained. In respect to the rate of reproduction and growth of our forest trees, and particularly those of commercial value, no investigation has been inaugurated, although the question is of fundamental importance in the formulation of any measures taken to prevent depletion. Systematic and careful studies in silviculture have been carried on in Europe, and the results obtained can be applied, with reservations, to the varieties and allies of the European species of trees that occur in Canada. For the species that are common to the United States and Canada the results of the investigations of American Forestry Departments are available. The climatic and soil conditions in Canada, however, are factors which render all the information derived from investigations carried on abroad more or less uncertain when applied to our forest trees, to promote their reproduction and growth under home conditions. There has not been, as yet, undertaken any systematic study of the biology of any of the Canadian species, a knowledge that is absolutely necessary to its successful cultivation. As regards rate of growth, we have no growth or yield tables, nor have we any volume tables which can be used in timber estimating. The only datum regarding reproduction, which seems to be unquestioned, is that the replacement of our cut timber requires more years than is generally believed. So far as forest culture in Canada is concerned, therefore, investigation of the rate of reproduction and growth is of the first order of importance.

In view of all these facts and considerations, the Advisory Committee of the Forestry Branch made the following recommendations:—

1. That the stock-taking of the timber standing in Eastern Canada should be completed, with particular attention to pulpwood supplies.

2. That a rapid reconnaissance, partly in connection with the stock-taking, should be made of the condition of cut-over lands as regards timber reproduction.

Google

3. That a study of the possiblities and successful methods of securing reproduction of our more important timber trees, notably the white pine and spruce, should be initiated.

4. That the necessary measurements be undertaken to determine rates of growth in volume of our most important timber trees, individually and in forest stands, to permit calculations of possible quantity of reproduction. As a preliminary to this work, the construction of volume tables will be necessary.

In consequence of the representations and advice given in this memorandum from the Advisory Board, Mr. Campbell, the Director of the Forestry Branch of the Department of the Interior, approached the Research Council with the request that it should give assistance in the achievement of the objects of the last two of the above cited recommendations. It was premised that these objects would require a number of years, perhaps ten at least, and a considerable annual outlay for their attainment, but, because of war-time conditions and the depletion of the staff in the Forestry Branch, the investigations required might be launched and conducted for several years in a modest way and at a moderate expense.

It was proposed that these investigations should be carried out on the Petawawa Military Reserve, a part of which, 25 square miles in extent, only is used for military purposes, the remaining 80 square miles being, therefore, available for this purpose. This is part of an old cut-over lumber district on which a second forest has begun to develop and the timber on it is, therefore, at a stage of growth which makes it very suitable as material for the investigations. The work, it was proposed also, should be carried on during the Summer season in each year, beginning with 1917.

The Research Council gave careful consideration to this request, and, recognizing the importance of the information which it was proposed thus to obtain, recommended to the Sub-Committee of the Privy Council for Scientific and Industrial Research that a grant of $6,000 be placed in the Supplementary Estimates for 1917 for the carrying out of this investigation.

Owing to the fact that these estimates were accepted only in July, the staff appointed to carry on this investigation did not begin work till August, and, accordingly, a preliminary survey, lasting two months only, was possible, but it was sufficient to furnish information whereby more carefully detailed plans were made for the work of the season of 1918, for which preparations of the Forestry Branch are already completed for a programme which will begin in May.

The expenditure for the season of 1917 was $2,490.32. The amount which the Research Council recommends to be allowed for the work of 1918 is $6,000.

The Research Council is of opinion that this investigation of the growth and reproduction of our forest trees, thus inaugurated and continued, will in a few years enable the Forestry Departments of the Dominion and Provincial Governments to inaugurate, on a scientific and practical basis, a scheme of reforestation, which will parallel the best results obtained in the past in Europe, and, in consequence, preserve for Canada one of her greatest and most enviable resources now in danger of exhaustion because of reckless waste and of the almost entire disregard of any system required for its preservation.

III. THE DETERMINATION OF THE EQUIPMENT AND MAN-POWER FOR RESEARCH IN CANADA.

Amongst the duties with which the Research Council is charged by the Sub-Committee of the Privy Council are:—

(1) The tabulation of all the agencies in Canada now engaged in scientific and industrial research;

(2) The scheduling of the various researches that are now being conducted by them; and

(3) The ascertainment of the man-power for research in the Dominion.

Google

The performance of these duties was necessary in order that all the data thus ascertained may be available for the development of all the scientific forces of the nation, to the end that its present industries may be advanced to the utmost and that new industries involving the utilization of the raw materials of our untouched natural resources may be established and their success assured. There were no data of this character previously compiled although information of an indefinite kind was current in certain quarters, but this could not be of much service in determining the exact situation as regards research in Canada.

It was therefore absolutely necessary that a systematic campaign should be made in order to secure all this information in a form that would enable the Research Council to know how most effectively to attack the problem referred to. After full consideration of the subject it was decided to issue a series of questionnaires, four in number, to each of:—

1. The Universities, Colleges and Technical Institutions;
2. Government departments, Dominion and Provincial.
3. Managers and directors of Canadian Industries.
4. Members of Scientific, Professional and Technical Societies.

The main objects of each of the first, second and fourth of these were to ascertain among other facts, the man-power for research in Canada, the researches that are being pursued either in pure or applied science, in the various laboratories and under private auspices, the researches that had to be abandoned or suspended and for what reason, the amounts that are spent annually to assist research, and the equipment and accommodation for carrying on research that each institution, or department of the same, possesses.

In questionnaire No. 3, addressed to the managers and directors of the industries, the data required were: whether they regularly employed researchers (chemists, physicists, engineers, or other experts, and whom), the research problems they attacked, the equipment and accommodation available for research, the amount of money spent in each industry for this purpose, the problems which require to be investigated in order to promote the further development of the industry, the raw materials used in the industry, the by-products resulting from the processes of manufacture, and so on.

The distribution of these questionnaires and their return properly filled out, especially that of No. 3 addressed to the industries, constituted a task of more than ordinary difficulty. In the number of industries listed in the census, amounting to more than ten thousand, are a very many which, although worthy in themselves, such as blacksmith shops, brickyards, lumber-mills, garment factories, cheese factories and Chinese laundries, do not in the present stage of the inquiry merit attention, but the character of these was not indicated, and, consequently, their sifting out would have had to be undertaken at the expense of time and great labour, had not the Canadian Manufacturers' Association, the Canadian Mining Institute, the Society of Chemical Industry, the Canadian Society of Civil Engineers, the Joint Technical Committee of Toronto and other technical organizations, each in its own sphere of activity, come to the assistance of the Research Council. These organizations were of additional material assistance. The return of these questionnaires, properly filled out, from each important industry, if not prompted by adventitious influences, would have largely been conditioned by such factors as apathy, indifference, temperament and a lack of knowledge of what was involved in this quest for information, and, consequently, the result would have been far short of what was aimed at. The organizations referred to volunteered to aid in this matter, and, accordingly, their members in various centres in the Dominion personally interviewed all the managers and directors of the important industries with the object of promoting the return of the questionnaires adequately filled out. As a result, after eight months of such volunteer assistance, about two thousand five hundred of these questionnaires, dealing with as many of the

Google

leading industries, are in the possession of the Council, and the information they give is now being extracted from them and put in a form which will serve for a thorough study of the present status of science in relation to the Canadian industries.

The Research Council takes this opportunity of warmly thanking the technical organizations and societies, and their members, for their help in achieving these results. It also desires to thank the managers and directors of the industries who have responded to the call for these returns.

Some of the conclusions drawn from the information which has been, and is being, gleaned from the returned questionnaires will be discussed in Section IV. It may, however, be said now that the situation is far from being satisfactory and that urgent measures are required to effect a reform which is of vital importance to the industries.

IV. THE STATUS OF RESEARCH IN CANADA—HOW RESEARCH MAY BE STIMULATED.

A discussion of the position that research occupies in Canada, to do justice to it, would require a much more lengthy presentment than may be given in a chapter or section of a parliamentary report, and, in now reviewing the subject here in its proper place, one must content oneself with a representation of the salient features of it.

As already indicated, the information regarding the status of scientific research in Canada, so far gathered from the questionnaires addressed to the industries, the Universities, the Technical Institutes and Technical Societies, reveals a situation which must cause concern in the minds of all who give thought to the grave problems that will confront us at the close of the war. The gravity of the situation is not wholly due to results of war conditions. Research in our Universities, Technical Colleges, and Government Laboratories is greatly handicapped, and in some institutions is not carried on at all, owing to depletion of the staffs caused by enlistment for military service, and this is true also for the scientific staffs of the laboratories of the industries throughout the Dominion. This is revealed in the questionnaires, and it has been taken into account in summarizing the situation. After making this allowance, however, there remains enough to show that the provision for research, either in pure science or in science applied to industry, has been and is utterly inadequate to our needs, and, consequently, unless vigorous action be taken, and soon, to reorganize our industries on scientific lines wherever possible, Canada will face a very serious industrial crisis in the years following the war.

To realize, however, how critical the situation will be, it is not necessary to go to the information derived from the questionnaires, as the financial prospects reveal it all too clearly. If the war continues for another year there will be a national debt of nearly one and a half billions of dollars, an annual budget of three hundred and fifty millions or more, and a consequently heavy taxation, of necessity, of all kinds.

With the exception of the United States and small neutral countries, other nations will be equally, if not more, burdened, and the burden will only be made tolerable by an increase in international trade, in which, however, the competition will be the keenest and most pitiless that the world has ever experienced. Each nation will organize itself for this struggle and neglect nothing that will in all likelihood promote success. Each will, accordingly, employ all the resources of the most advanced scientific knowledge in the conduct and management of its industries. The nation that fails to do so will be hopelessly handicapped in this struggle, however otherwise it may strive to avert the inevitable result. The new era, therefore, which is about to begin for Canada is one whose industrial problems are to be of such magnitude as to compel a radical recasting of all our industrial methods, and, above all, of the attitude of the Governments, Dominion and Provincial, on the one hand, and of those in control of the industries, on the other, regarding the claims of scientific research as an all-important factor in the promotion of industrial development.

The state of unpreparedness in Canada for the eventualities of the coming trade struggle cannot be regarded as unique. It was characteristic of Great Britain, Australia, New Zealand, and South Africa. The Imperial Government had till three years ago neglected to make any provision for scientific research[1], except small annual grants to the Royal Society and to the National Physical Laboratory. Research was, however, carried on by private workers and by the teachers in science in the various university laboratories working under discouragements that would have daunted all but the most enthusiastic and courageous in the cause of science. Their contributions to pure science during the last thirty years constitute a just claim to international recognition as a noble achievement in idealism. But they were a class apart, and the Government and the Nation ignored what they represented and paid scant attention to the warning they gave, that the control of the basic national industries was passing into German hands. In consequence, the war found the nation unprepared and lacking in very many of the materials vitally necessary, not only for carrying it on, but also for the continuation of some of the more important industries. The shock of the revelation of the situation swept away, it is hoped, forever the traditions which made the nation, as a whole, indifferent to research as a factor in national progress and development. At once an Honorary Advisory Council for Scientific and Industrial Research was brought into being, which has for the last three years been endeavouring to foster, by every means at its command, research in pure and applied science. As a result of its efforts, a Government Department of Scientific and Industrial Research has been created which has received a parliamentary vote of £1,000,000 to be spent in aiding research in relation to the industries during the five years beginning April, 1917.[2] It would seem that the impression made on the national mind is of too deep a character to wear out, and one gets corroborative evidence of this in the latest manifesto of the Labour Party of Great Britain.[3] Some of its sentences are significant:—

> . . . . "Especially in all the complexities of politics, in the still undeveloped Science of Society the Labour Party stands for increased study, for the scientific investigation of each succeeding problem, for the deliberate organization of research and for a much more rapid dissemination among the whole people of all the science that exists. . . . An autocratic Sultan may govern without science if his whim is law. A Plutocratic Party may choose to ignore science if it is heedless whether its pretended solutions of social problems, that may win political triumphs, succeed or fail. But no Labour Party can hope to maintain its position unless its proposals are, in fact, the outcome of the best political science of its time; or to fulfil its purpose unless that science is continually wresting new fields from human ignorance. . . If law is the mother of freedom, science to the Labour Party must be the parent of law."

All classes are behind the new movement and it is evident that a new era has dawned in Great Britain, an era in which scientific research will be promoted with all the ardor and energy the nation can put into a continued effort to repair the effects of the gigantic mistake of neglecting science during the last forty years. The lesson taught has been also heeded by Australia and South Africa, and their Governments have early followed the example of the Imperial Government by instituting Research Councils. That of the Commonwealth has proposed the establishment of an Institute of Science and Industry in which will centre all the directive forces of the new movement for science. In New Zealand efforts are being made to bring about the establishment

[1] For a critical representation of the attitude of the nation and the Government towards science, see "Neglect of Science," giving the proceedings of a conference of the leading scientific men of Great Britain, held on May 8, 1916. Published by Harrison & Sons, St. Martin's Lane, London.

[2] The Department receives also an annual vote from Parliament which for 1918-9 exceeds £200,000.

[3] "Labour and New Social Order. A Draft Report on Reconstruction." The Labour Party, 1 Victoria street, London, S.W. (Published January 1, 1918.)

Google

of an organization which will function more or less like a Research Council. Everywhere throughout the Empire there has occurred, in regard to the attitude of the State towards scientific research, a complete break with the past.

The neglect of science in Great Britain was due to a monopoly exercised by the old learning in all the educational and political circles, supported by individualism and the cult of the laissez-faire principle, the result of the traditions of five hundred years of history. The monopoly had its effect on the industrial classes and resulted there in a contempt for what was known as scientific as contrasted with what was called practical. In Canada, as in the other British Dominions, this attitude towards science had its origin, in large part, in the same traditions. Our educational system is still almost wholly literary, and, in consequence, the directive force of public opinion is very largely influenced by the traditions that hampered progress in science in Great Britain.

It was perhaps natural that it should be so. In the earlier days of our history, from fifty to one hundred years ago, modern science was as yet undeveloped or in its evolutionary stage, and the Universities and higher educational institutions of to-day which were then founded were devoted almost wholly to literary learning, from the dominant influence of which they are by no means as yet free. Science in Canada has, therefore, not come into all her own in the academic world. The work of the eighteen Universities is still in the main along lines outside science. Their Departments of Science, pure or applied, are of comparatively recent origin and the majority of them, it must be said, are very inadequately maintained. Not one of the four or five Faculties of Applied Science is older than forty years, and though several of these have done excellent service so far as their staffs and equipment go, they have been unable to compete in achievement with institutions like the Massachusetts Institute of Technology and other equally equipped Technical Institutions, whose services to industrial science in the United States have been of enormous value. They do not get the financial support that is extended to any of the six or seven best American technical schools. The annual budget of the Massachusetts Institute of Technology exceeds the total of the annual expenditures of all the Faculties of Applied Science in Canada.

The apathy regarding the claims for greater assistance for Applied Science Faculties is due to the fact that public opinion in Canada has not been educated to the point of conceding the principle that science, pure and applied, is quite as vital a concern of the State as is national safety. In consequence, the support of science has hitherto depended in great part on private generosity, which is now heavily taxed for other objects. A continuation of this laissez-faire policy is impossible, for to-day Canada faces an immediate future in which efficiency in science and scientific research must be attained or its industries will be enormously handicapped in the competition with their rivals abroad, who are even now relying for success in this contest on the resources that the most advanced expert knowledge and research are placing, and will place, at their disposal. The State can no longer disregard the claims of science nor can its industries be indifferent thereto.

There are industries in Canada on which the blight of apathy or indifference has not yet fallen. The managements and the directorates of such are conscious of the urgency of the measures that must be taken to meet the issue pending. The capital involved in each is, however, small, and, as research is expensive, they are not, individually, in a position to undertake it, or if they do so, it cannot be on such a scale that will guarantee successful results. For these the outlook is not encouraging unless they combine their resources for a common effort to meet the expenditures required. These industries could enroll themselves in American Associations formed for the purpose of solving their problems by research. Some have indeed already done so. The American Canners' Association, which supports a research laboratory with an annual budget of about $35,000, lists in its members a number of Canadian Canning Companies.

Such a co-operation may be unobjectionable, and, indeed, is in some cases desirable. There are no international boundaries in Science, and the research problems which must be solved in the development of the industries ignore geographical limitations. But there are reasons why this co-operation cannot be erected into a general system. Some of these concern a cast of psychology inscrutable in the ultimate, if you will, but, nevertheless, potent in directing a policy on this question. Our people could not ultimately be brought to approve of any proposal, however luring it migbt appear to them, if also its acceptance involved an effacement of the pride and independence that nationality essentially predicates.

The Canadian industries must, therefore, constitute organizations of their own if they are to contribute to the solution of their own industrial research problems. This may be done by following the plan formulated by the British Advisory Council and adopted by the Department of Scientific and Industrial Research. By this the Firms in a particular line of industry are encouraged to form trade associations for research, which will periodically survey the conditions in their respective industries, determine what problems require investigation and initiate researches thereon. The funds for this purpose will be derived by a levy on, or subscription from, the Firms, and, if these are not sufficient, assistance may be given for a period of years by the Department, derived from the grant of £1,000,000 made by Parliament for a five-year budget for the purpose. By this method the systematic development of research and the co-operation of science with industry will be carried out under the direct control of the industries themselves. Researches may thus be undertaken which could not have been dealt with by the individual firms.

The great majority of the Canadian industries, it may be repeated, are relatively small, and, consequently, have individually not the resources required to undertake research. They are then of the status of the British industries for which trade Associations for Research are now being promoted by the Department of Science and Industry. Such Canadian industries could combine, in their respective lines, as Guilds for Research, the funds for which could be derived from assessments of the individual Firms constituting each Guild, the funds to be supplemented, when not sufficient for their objects, by grants from a special parliamentary vote for this purpose. The fund for eacb Guild could be expended by a committee or board appointed by the Council of the Guild, and the results of the researches obtained would be available for the benefit of each firm in its membership. The members of such guilds could be accorded other advantages as their arrangements might provide.

Such advantages as theso may be suggested:—

1. The right to recommend specific problems for researcb, which must be passed on by the board or committee, and, if approved, carried out without cost to the Firm recommending that the research be undertaken.

2. The right to a periodical service of information for the purpose of keeping it in touch with all the technical developments in this industry, even to the extent of receiving copies of articles, translated if originally in a foreign language, bearing on any subject concerned in the industry. Tbis would cover also answers to technical questions which a Firm may propose.

3. The right to the use of all patented or secret processes which may result from the researches undertaken by, or at the expense of, tho Guild.

Otber rights or privileges may be guaranteed by stipulation in order to suit the circumstances or situation in any particular industry. Firms in an industry, not members of its Guild, would be excluded from all these privileges, and, especially from the use of all Patents granted to the Guild on any process resulting from a research conducted at tbe expense of the general fund of the Guild. Information as to secret processes would also be denied to them.

There are a number of trade assooiations in Canada, which may be constituted into Guilds for Research such as the Tanners' Association, the Textile Association, the

Google

Pulp and Paper Association, the Clay Products Association, etc. Whether they can be induced to do so must depend on their capacity to meet the new conditions and on the recognition of the value of science and research in helping them to a sure foothold in home and foreign markets.

How far aid should be extended to such Guilds must be determined by the conditions attendant upon each line of industry. Ordinarily, when given it should not, except under special circumstances, be in a direct form but in such a way as to stimulate to the utmost private effort and enterprise in industrial research. If a Guild were provided with ample resources of its own for this purpose, it would be in a position to provide its own laboratories and maintain them and a staff for research to the extent required. For Guilds less well circumstanced such establishments are impossible, for the erection and equipment of small independent laboratories will be beyond their means. To reduce the burden to such and to enable them to concentrate their resources on their necessary researches, it would be advisable for the State to provide them room accommodation in a large laboratory with free light, heat, and, where necessary, motive power, and in which they could place research staffs maintained by them. Relieved thus of the initial cost of laboratory construction and of the expense of the maintenance of the laboratory rooms, each Guild could devote all its funds for research to the solution of its immediate and urgent industrial problems.

Such a system of Guilds directing their energies to research for the purpose of improving their manufacturing processes and thereby increasing Canadian trade would justify the State taking the initial expenditure and meeting the slight annual charges for maintenance. A dozen or more such Guilds would, thus recognized and assisted, transform in the end tbe spirit of enterprise of Canadian industry. It would lead all lines of industry to follow the example thus set and at least enable them to hold their own in the time of stress that is approaching.

A laboratory establishment of this kind has its existing exemplification in the Mellon Institute at Pittsburgb, founded and endowed by the Mellon Brothers in 1911, and placed under the management of a staff of directors. This Institute has already shown that it is of great service to individual industries which have availed themselves of the privileges it offers. Several of them have enormously benefited thereby, one, the American Bread Company, as a result of a research so instituted and supported, having already reduced the cost of one of its departments by a sum more than equivalent to the cost and equipment of the Institute. It is, indeed, not at all improbable tbat other establishments like the Mellon Institute may be established at different points in the United States in the near future.

Such a laboratory establishment, founded for tbe use of Guilds by the Government, could be most economically administered in connection witb a Central Institute for Research. The staff of such an Institute, in addition to the duties it would have of directing and carrying on research in its own proper sphere, would serve in an advisory capacity to the investigating staffs appointed by the Guilds to investigate their own problems. Further, with common heating and lighting equipments, the overhead expenses for such a united Research Institute and Guilds-Laboratories would be reduced to the minimum possible.

The question of the establishment in Canada of a Central Research Institute has been discussed by the Research Council at great length at its meetings for the last nine months and all aspects of it have been passed under review. The facts and considerations which tell for, as well as those which tell against, the proposal to establish such an Institute have been carefully considered and the Council has taken pains to get the views of those whose experience under other conditions makes their opinions of value, whether it be in favour of, or against, the proposal. The Cbairman on several occasions in 1917 consulted, collectively and individually, the heads of the various Technical Bureaus in Washington on the subject and a majority of the members of the Council visited that city in February for the express purpose of discussing with these officials and others all the facts and views bearing on the question. On this occasion two

séances of three hours each were held at which every phase of the subject, regarded in the light of official experience, was gone into. There is no systematized organization of these National Technical Bureaus, each of them having been instituted as the need arose, without provision having been made for its co-ordination and co-operation with those earlier established, and, in consequence, the situation cannot be described as ideal, either from the point of view of economy or as regards efficiency, although the various Bureaus have done, and are doing, signal service. It was this lack of system that was admitted, almost generally, as the cardinal defect of the Bureaus, a defect that cannot now be readily remedied and it should be provided against in Canada, according to the advice of the officials consulted.

In Washington there is a Bureau, the Bureau of Standards, of recent foundation, the function of which is to deal with standards of all kinds, of length, weight, time, mass, quality and performance, specifications of material and determination of physical contents. The departments with which it concerns itself are heat, electricity, optics, chemistry, metallurgy, ceramics, and structural engineering. The equipment is a very extensive one. The Bureau carries out tests of materials, contractors' supplies, etc., required for the various Government Departments. Very cordial co-operation exists between it and the industries which it endeavours to serve along the line of its functions. It has undertaken researches in conjunction with some of the leading Manufacturers' Associations. When an investigation undertaken for a private Firm or a Company is not likely to give results of common application to a considerable section of the public, the Firm or Company is charged with the expense incurred, but, if it may possibly lead to general public benefit, the research is carried out at public expense. The Bureau has already completed in the seventeen years of its existence a large number of researchs in pure science, the results of which have been published in Bulletins, thirteen volumes of which have already appeared. For the erection of the laboratories already completed about one million dollars have been spent and the Congressional appropriations for salaries of a staff of 700 and maintenance for the year ending June 30, 1918, total $1,073,000.

There are elsewhere organizations whose functions parallel those of the Bureau of Standards. The National Physical Laboratory at Teddington, near London, founded in 1900, and carried on in a modest way till 1914, has a staff of 500 and expends annually nearly £150,000. Besides concerning itself with standards, physical, mechanical and metallurgical of all kinds, that is, as a national testing house, it functions as a laboratory for industrial research, and in this latter role it will come into close relation with the Trade Associations for Research. In Charlottenburg, a suburb of Berlin, is situated the Physikalisch-Technische Reichs-Anstalt, which is the Bureau of Standards for Germany. Before 1912 it practically served as the testing house for all the world.

The establishment of such Bureaus is projected elsewhere. The French Government has already provided for one and the Japanese Government has undertaken the establishment of an organization which will have all the functions of an Industrial Research Institute and a Laboratory for Standards. Under the Institute for Science and Industry, as proposed by the Australian Advisory Council of Science and Industry, there will be provided National Laboratories "for special purposes of research and experimental inquiry, including a physical laboratory for testing and standardizing purposes," with which the present Government Laboratories may be co-ordinated.

There is no institution in Canada corresponding to the Bureau of Standards, nor are its functions performed by any of the laboratories of the Government Departments, although in the Mines Branch of the Department of Mines problems in metallurgy, ceramics and fuel-testing are very efficiently dealt with and in the Forest Products Laboratory connected with the Forestry Branch of the Department of the Interior special researches have been, and are being conducted on problems connected with the pulp and paper industry, from which valuable results have been obtained.

In consideration of these facts, which are advanced to show the general agreement as to the urgency for each State to provide for organized research by the establishment of Institutes or Bureaus for Research to assist the development of the industries of each, and also because of the special need in Canada of one such, the Research Council has approved of the proposal that a Central Research Institute be established at the earliest possible date, whose function will be that of carrying on research, not only in pure science in relation to standards of measurement, quality, and composition of material, but also in science applied to the industries of Canada.

In the building which should house the Institute there should be a considerable number of laboratory units, or series of rooms, provided with free light, heat, and, where necessary, motive power, to be available for use by the various Guilds for Research formed by the Firms in the various industries to enable them at their own expense to carry on investigations with a view to improving the technical processes of such industries.

The establishment of such a Central Research Institute should be initiated on a modest scale, but on a plan which would readily admit of additions or growth without disturbance of symmetry or alteration of the basis of its constitution, or of its management.

Whether local branches of this Institute should be formed is a question which the Research Council, though it has considered the subject, is not prepared to offer a recommendation. The question also of the relation of the University laboratories to this Institute has likewise been considered, but the solution of it is not vital to the realizattion of the main proposal, and can be determined at a later stage. The need of a Central Research Institute is a pressing one, and that must come first in the order of the programme.

The work of the proposed Institute would powerfully aid the development of scientific research in Canada by stimulating the Canadian Universities to increase their resources and facilities for research, and thereby to direct into the ranks of science the ablest of their young graduates desirous of qualifying for a career whether in pure science or in science applied to Canadian industry. It would place at the service of Canadian industry a factor which would ensure its success in the strenuous international trade competition which is near at hand. It would, above all, enable the nation to direct its energies towards the economic and right utilization of its untouched stores of national wealth, in order that it may bear, with some degree of ease, in this and the next generation the almost Atlantean financial burden it is assuming as a result of its playing its part in the present world struggle.

V. ASSISTED RESEARCHES.

The Council, during the last year, received applications for grants for assistance to researches which totalled more than $80,000.

The Committee on Assisted Researches carefully considered these applications, and finally reported a number which, in its opinion, were of immediate practical importance, and which, also, were capable of being conducted to a successful issue within a reasonable period of time.

The Council adopted this report and made the grants called for. These grants are as follows:

1. The investigation of tar fog, carried out by the Council employing Dr. J. G. Davidson, Professor of Physics in the University of British Columbia—$5,000.

2. The utilization of the waste straw for the production of gas for heating and lighting farm houses, by Professor R. D. MacLaurin of the University of Saskatchewan, and Mr. Harrison of Moosejaw—$1,500.

3. An investigation regarding the transmission of sound with a view to improving methods of fog signalling, by Professor L. V. King, Physics Department, of McGill University—$600.

4. A study of Canadian waste tobacco with a view of preparing nicotine sulphate, under Dr. R. F. Ruttan, carried out by Mr. A. D. Hone—$500.

5. The determination of vapours in gases under Professor Parker of Manitoba University, carried out by Dr. H. S. Davis with assistance—$1,000.

6. Possible uses of the tar sands of Alberta, under President Tory of the University of Alberta, with the assistance of the members of his staff and associated engineers—Amount of grant undetermined.

7. Experiments on the application of the principle of flotation to new economic ores, in charge of Prof. J. B. Porter—$700.

8. The amount and character of the sugar in sulphite liquor waste, carried out by Dr. V. J. Krieble, under Dr. R. F. Ruttan—$200.

9. The genetics of wheat, carried out by Professor W. P. Thompson of the University of Saswatchewan—$2,000.

10. The reduction of low grade ores by means of gas at a comparatively low temperature, under Dr. A. Stansfield, Professor of Metallurgy, McGill University—$2,500.

Detailed Specifications of the Assisted Researches.

1. *Tar Fog Recovery.*—The Council, recognizing the national importance of conserving economically the products of destructive distillation of wood, coal, and the liquid products produced during the manufacture of producer gas, etc., engaged Dr. J. G. Davidson, of the University of British Columbia, to make investigations on a commercial scale.

The principle was the application of the Cottrell precipitation process to the recovery of the heavy liquid and solid matter passing over in the hot gases resulting from distillation. Preliminary experiments had shown Dr. Davidson that a very effective separation of the heavy materials from water and gas could be effected by the electrical discharge in the Cottrell system. A plant on a commercial scale was established at Sault Ste. Marie, in connection with the coke works in that centre. Numerous difficulties developed in the course of the experiments owing to the clogging of the pipes by tar, and the short circuiting of the system brought about by carbon particles. Great delay also occurred owing to the difficulty of obtaining machinery and equipment. Dr. Davidson was required to pick up one by one and assemble the portions of several of the units required.

The plant was assembled at the beginning of December, 1917, and in April, 1918, the major difficulties of working on a large scale had been overcome, and the process demonstrated that a great saving could be effected in recovering the products of the destructive distillation of wood and tar, as these can be separated from steam and gas at a high temperature so that subsequent evaporation and treatment of the water mixture were avoided.

This process will probably be utilized by several of the distillation plants in Canada in the near future. Dr. Davidson intends to make his interest in this process in some way a public asset when it is developed. The installation and power costs of this process are low and the action has been shown to be very effective.

2. *Straw Gas.*—Some plan for the utilization of the thousands of tons of straw which are annually burned in the Prairie Provinces appealed to the Council as being one of national importance.

Prof. R. D. MacLaurin, of the University of Saskatchewan, and Mr. Harrison, of Moosejaw, have carried out some experiments which resulted in the development of a

Google

form of retort which enabled them to distil the compressed straw and obtain from it a large yield of gas of high heating powers and a residue of carbon which could be used as fuel and for other purposes. With a view of developing this process on a commercial scale and demonstrating to the farmers of the Western Plains a method of utilizing their waste straw, a grant was made to these gentlemen to continue their research on a larger scale. This grant was given to enable them to obtain material and construct two or three retorts, one of which was to be erected at or near the University of Saskatchewan, where very accurate records of the conditions of combustion of the straw could be made, and one or two installed in farm houses, with full equipment necessary for heating and lighting them. This investigation and demonstration is now under way, but has been seriously delayed owing to the great difficulty in obtaining the materials and castings required for the retorts. It is expected by this to demonstrate that retorts and distilling apparatus of very simple design and automatic in operation can be supplied to the farmers at a cost of about $500.

3. *Fog Signals.*—A grant was made to Prof. L. V. King of McGill University, to enable him to employ and obtain apparatus to develop the efficiency of fog signalling apparatus. The work was conducted in co-operation with the Department of Naval Service and with the assistance of some experts from American Universities and from Washington, chiefly at Father Point, Quebec.

The objects of the experiments were to investigate the construction and testing of an apparatus from the direct measurement of the intensity of sound waves generated by powerful sirens, to determine the nature of the large energy loss in the development of sound, and thus to compare the efficiency of the various types of fog horns and sirens used for signalling purposes in the St. Lawrence River and the Gulf.

To sum up the results achieved by the tests referred to above, it may be stated that methods of measuring sound quantitatively and qualitatively have been developed and tested in practice. The acoustic characteristics of a siren may now be determined with fair accuracy in absolute measure, whereas, previous to these experiments, an almost complete ignorance existed on these points. Measurements of the intensity of the master tone may now be carried out at distances of several miles and the influence of meteorological conditions on the propogation of sound may be studied in the light of accurate data. These achievements conclude an important chapter in practical acoustic engineering.

(A synopsis of the work accomplished will appear in the form of a Bulletin in the month of April.)

4. *Nicotine from Waste Tobacco.*—Dr. Hewitt, Dominion Entomologist, called the attention of the Research Council to the very high cost of the most valuable insecticide for certain shrubs and fruit trees, namely, nicotine sulphate. This could only be obtained from Kentucky, and cost the Canadian fruit growers $1.25 per pound. He asked whether it would be possible to obtain a sufficient supply from the waste tobacco of Canada. In 1916, over 2,000,000 pounds of tobacco waste of various kinds were produced in Canada, this waste tobacco then selling at ¾ cent to 1¼ cents per pound.

The Council asked Dr. Ruttan to obtain some one to ascertain whether the waste stems and leaves of the various tobacco factories in Canada could be utilized for the production of this valuable alkaloid. This investigation was carried on by Mr. Arthur D. Hone in the laboratories of the University of Toronto. A determination was made of the nicotine from the soaking of the leaves in the factory, and also of the various wastes in the form of stems, dust, etc. It was found that the stems of Canadian tobacco gave about 2·4 per cent of the alkaloid, and a good yield was also obtained from the dust and scraps. It was demonstrated that, at the current price, nicotine sulphate could be economically manufactured from Canadian refuse. The research

was carried further with a view of determining the most economical method of extraction. These waste materials were found to contain, in addition, a very high percentage of potash; quite sufficient of this valuable chemical to justify its extraction, approximately 7 per cent was found in the leaves and stems. The research was begun in the summer of 1917, and practically completed in March, 1918. The full report is now in process of preparation by Mr. Hone and Dr. Ruttan. Owing to the enormously enhanced value of tobacco waste, since the research was undertaken, it is questionable whether the utilization of the important results of this investigation can be undertaken until after the war.

5. *Determination of Vapours in Gases.*—A research was undertaken by Dr. Harold S. Davis, assisted by Mary D. Davis and Donald C. McGregor, under the supervision of Prof. M. Parker of Manitoba University, on the detection and estimation of vapours in gases.

This research was directed towards devising a method for determining the amount of benzene and toluene vapours found in gases such as coal gas, products of distillation of wood, etc. A form of apparatus has been devised which enables a chemist to determine accurately the amount of these vapours in coal gas. The apparatus has been reproduced and has been sent to England to be used in the recovery works in the various gas plants under the Imperial Munitions Board.

Three papers have been published on the extension of this work: (1) "A new method of the quantitative estimation of vapours in gases." (2) "The estimation of benzine and total light oil content of gases." (3) "The study of the absorption of light oils from gases."

The last paper is of great value in determining the conditions necessary to obtain a maximum amount of these valuable light oils during the carbonization of coal.

The work on this research is nearly completed, but still further study is being made to determine the best possible conditions for the recovery of toluene from gases during distillation.

6. *The Tar Sands of Alberta.*—A research has been planned on the chemical and physical properties of the very large deposits of tar sands found in northern Alberta. Some preliminary work had been done in connection with these sands by Mr. S. C. Ells and some experiments were tried in Edmonton to demonstrate their value in the construction of pavement, similar to asphalt. The latter went to show that the material required very little mixing with other substances to produce a paving as durable as the best asphalt. It was deemed advisable to make more thorough study of the chemical composition of the tar itself as well as to investigate the best methods of extracting the tar commercially and the preparation of road materials and other commercial products from the tar of the raw material.

President Tory has undertaken the organization of a number of members of the staff of the University of Alberta with other engineers and chemists to make a thorough technical investigation of the value of these tar sands. Owing to President Tory being called to Europe, little progress has so far been made in this organization, but, under Professor A. F. L. Lehmann and Mr. W. F. Seyer, considerable advance has been made in ascertaining the chemical composition and products resulting from the distillation of these tars. Certain pieces of apparatus and machinery have been gathered this winter for a thorough study of this problem, and arrangements have been made for the delivery of a large quantity of the tar sand in Edmonton during the coming summer.

7. *Application of Flotation to New Ores.*—Under the supervision of Dr. Porter and Dr. Bell, of McGill University, a study is being made of the relative value of Canadian oils and imported oils for the flotation of ores and also of the application of the flotation process to Canadian ores not being at present satisfactorily treated by this process.

The grant was made to enable Professors Porter and Bell to obtain the materials required and the services of Mr. J. M. Scott to make the control analysis.

The experiments carried on so far have been with a view of comparing the value of certain waste oils obtained during the distillation of Canadian woods with those now imported into the country. The flotation process, using Canadian oils, has been applied to copper ores from the Bruce Mines, zinc ores from Notre Dame des Anges, and to several ores from British Columbia which have not hitherto been treated by the flotation process. The complete results have not as yet been reported.

8. *The Sugars in Canadian Waste Sulphite Liquors.*—A research on the composition of sulphite liquor waste with a view of obtaining from it ethyl alcohol and other commercial products was undertaken, under the direction of Dr. R. F. Ruttan, by Dr. V. J. Krieble.

Several of the sulpbite pulp mills, on the suggestion of the Associate Chemistry Committee of the Council, contemplated the production of ethyl alcohol from sulphite liquor waste by fermenting the fermentable sugars which are found in this waste liquor. This process has been carried on commercially in Sweden for a number of years, and has recently been undertaken in Mechanicsville, N.Y.

It was necessary, as a fundamental study, to determine whether the sulphite liquor waste, produced from Canadian woods by the processes employed in our pulp mills, would yield the required amount of fermentable sugar, and, secondly, whether the process in these mills could be so modified as to increase the amount of fermentable sugars, if alcohol plants were established.

Dr. Krieble is also studying the variety of yeast which will yield the largest amount of alcohol from our Canadian waste liquors, the various forms of sugar which are found in these wastes and the percentage available for conversion into alcohol. The research is nearly completed, and it has been found that the sulphite liquors from three of the five mills studied gave a better yield of fermentable sugar than is obtained at the Mechanicsville plant.

It is thus established that the waste liquors of our sulphite mills can be economically used for the manufacture of alcohol, and two of the largest Firms concerned are now negotiating with the Imperial Munitions Board and with the holders of the patents with a view of establishing an alcohol plant in the immediate future.

9. *The Genetics of Wheat.*—A grant has recently been voted to Prof. W. P. Thompson, of Saskatoon, to enable him to obtain the assistance necessary to develop a variety of wheat which will mature at an early period in the season, and which will be rust-resisting. In the opinion of experts, the method proposed by Mr. Thompson is very likely to yield results of great value to wheat growers of the Northwest.

The research is now in progress.

10. *Reduction of Low Grade Iron Ores.*—Another research has been recently undertaken by Prof. A. Stansfield, professor of metallurgy at McGill University, to carry out, on a semi-commercial scale, experiments on the reduction of low grade iron ores, which abound in Canada, by means of reducing gases at a comparatively low temperature, with the idea that the final fusion and reduction can be carried out in small electrical smelters at a number of localities in the country.

This research has not yet begun, but will be taken up during the coming summer.

APPENDIX A.

SUMMARY OF THE ACTIVITIES OF THE ASSOCIATE COMMITTEE ON CHEMISTRY FOR THE YEAR ENDING MAY 1, 1918.

REPORT OF PROF. R. F. RUTTAN, CHAIRMAN.

The Committee was organized by the Council at the August meeting, 1917. Two reports of progress have been transmitted to the members of the Committee by the Chairman. In these reports were outlined the main chemical problems which had been brought to the notice of the Council, either by special letter or arising out of the questionnaire which had been distributed during the summer. The members were informed regarding studentships and fellowships, assisted researches, and the enactments of the Department of Militia and Defence regarding the exemption of technologists. Among the more important questions studied by the committee were:

1. *The Production of Potassium Salts in Canada, and the Possibility of Increasing the Output.*—Enquiries were sent to the various members of the committee and a very complete synopsis of the literature of the subject was obtained. It was found that Mr. B. C. Emslie of the Division of Chemistry, Department of Agriculture, had studied the production of potash fertilizer from the kelp and rockwood at Clark Harbour, and obtained very encouraging results.

The report of Mr. A. T. Cameron on the commercial value of the kelp beds of the Pacific Coast estimated that these beds could supply alone more potash than is used at the present time in Canada, and recommended the establishment of a plant. The committee was unable to find that any of the processes for obtaining potash from potash feldspar was being carried on in a large commercial scale, but that several preliminary investigations were under way in Ontario and elsewhere to find a commercial process.

A commercial process for obtaining potash from feldspar and from the glauconite of the green sands of New Jersey has been established, but the by-product, which is a brick of very great value, is more important than the potash, so the process employed is used for the production of high grade brick with 4 per cent. to 6 per cent. of potash as a by-product.

It was found that the ash from the soft woods of British Columbia and from straw did not yield potash in commercial quantities. The condensation of the vapours and dust from cement works has been a profitable source of potash in the United States. One of the larger cement works in Canada is now introducing the Cottrell process for the recovery of this by-product in cement making. There is little doubt but the dust from other cement plants might be economically recovered. This waste dust should be analyzed in all cement plants.

It was found that a considerable amount of potash is being made in Canada from hardwood ashes, a revival of the old industry, and in the larger cities these hardwood ashes are being collected and leached.

A certain amount is also produced, as for instance in New Toronto, from garbage, and also from the waste liquor from sugar works, e.g., the Dominion Sugar Company in Chatham.

The Geological Survey report that as yet they have not been able to find any salt lakes or other deposits of potash salts sufficiently rich to justify their use as a source of this chemical.

The deposits of alunite in Canada are so limited that they have not been seriously considered, although this mineral is worked in the United States.

The rock known as nephelin syenite, found in the vicinity of Bancroft, Ont., which carries 4 per cent. to 5½ per cent. of potash, is being investigated with a view of obtaining a potash fertilizer, which will relieve the present shortage in the market.

Every encouragement has been offered to those who are investigating methods for obtaining potash salts from feldspar. Some seven or eight processes have been suggested, which, though feasible on a laboratory scale, were found not to be commercially profitable methods. The solution of this problem, so important in Canada, will be accomplished when a simple method of decomposing the mineral is found which gives, besides the potash, a valuable by-product of wide utility.

2. *Fish Waste.*—The Committee recognizing the great demand and necessity for an increased supply of fertilizers has been making a study of the availability of the fish waste on the Atlantic and Pacific Coasts as a source of nitrogenous and phosphate fertilizer, and also of protein food for cattle, hogs, and poultry.

The fish waste in Canada amounts to over 300,000 tons per annum, but probably not more than half of this would be available for conversion.

The data collected by Dr. McIntosh on the Pacific Coast, Mr. Mackie in Cape Breton, and more especially the valuable information obtained from Mr. J. B. Feilding, led the committee to recommend to the Council that a port survey should be made of the two coasts to ascertain the total quantiy of waste available, the amount that could be economically collected at each point, the fluctuations in the catch throughout the year, and the availability of fish of no present marketable value, such as dog fish. Fish waste is now manufactured into food stuff and fertilizer in California and Washington, very profitably. It has been shown in Sweden and in Germany that a valuable concentrated protein food for cattle can be procured from this waste, and the possibilities of preparing such in Canada are being investigated. With the present prices of protein at $2 per unit, and ammonia at $6.40, the undertaking should be a very profitable one.

The oil, even in a crude form, which can be obtained from this waste, is also a valuable asset to the industry.

The Committee has obtained plans and prices of several forms of apparatus now employed for the purpose of converting this waste into a marketable product and Mr. Feilding is making a preliminary port survey of the Maritime Provinces on behalf of the Council.

3. *Industrial Alcohol from Wood Waste.*—The Imperial Munitions Board in November last called the attention of the Research Council to the desirability of stimulating the production of ethyl alcohol from other sources than grain.

There are three recognized sources of ethyl alcohol from materials which are not foods, two of which might be profitably worked in Canada, namely, the utilization of wood waste and the fermentation of the sugar found in the sulphite liquor waste. The third and most profitable source of industrial alcohol, namely, the waste molasses from crude sugar, is not available in Canada.

Your Committee has been in consultation with Mr. George H. Tomlinson, who is a pioneer in the hydrolysis of sawdust and other wood waste and their conversion into ethyl alcohol.

A company was formed with a view of establishing a plant in Ottawa to manufacture alcohol from waste sawdust. This project is now being seriously considered by several of the large mill owners in the Ottawa district. It is necessary to obtain about 300 to 500 tons of wet sawdust per day in one locality to make the process commercial, and this should be delivered at a cost of a little more than 50 cents to 75 cents per ton to the converters; 300 tons of moist sawdust will yield about 60,000 pounds of glucose, or about 30,000 pounds of alcohol per day. This alcohol is now produced in the United States at cost of about 30 cents to 40 cents per gallon of 95 per cent strength. The objection urged against the establishment of a plant of this sort in Eastern Canada is the shortness of the season and the cost of the raw material. This objection does not hold true for British Columbia, where enquiry

has shown that from 300 to 400 tons of sawdust per day can be secured at or near New Westminster for twelve months in the year.

There seems every prospect of the establishment in the immediate future of an alcohol industry from waste wood in British Columbia.

4. *Industrial Alcohol from Sulphite Liquor Waste.*—Very considerable progress has been made towards establishing industries in Canada for the utilization of the fermentable sugars in sulphite liquor waste for the manufacture of ethyl alcohol.

Dr. J. S. Bates prepared a memorandum from the literature of the character of the process and the methods employed in Sweden and in Mechanicsville, New York, for the preparation of ethyl alcohol from the sulphite liquor waste.

With the co-operation of the managers of the Laurentide Company and the Belgo-Canadian Pulp and Paper Company, Limited, careful estimates were prepared as to the cost of production of the alcohol in Canada. This report was transmitted to a number of paper mills, and at a meeting held in January last it was decided to take steps to determine definitely the cost of the works, the amount of alcohol which could be obtained, the arrangements by which the patents controlling this process could be used, and the methods now employed in the United States. A careful investigation was made of the mechanical and engineering side of the problem by the Laurentide Paper and Pulp Company, and a careful analysis of eleven samples of Canadian waste liquor was made in the laboratories of McGill University, where a study of the conditions of fermentation was also undertaken. The waste liquor of the Canadian mills gives a higher content of fermentable sugar than that found in the liquor employed in Mechanicsville.

It has been estimated that 2,000,000 pounds of alcohol can be produced at a net cost of less than 40 cents per imperial gallon of 95 per cent. alcohol from the waste liquor of two of the pulp mills of the St. Maurice valley.

A number of meetings have been held between the members of the Chemistry Committee and the managers of the pulp mills, and it seems very likely that at least two works will be established for the utilization of this noxious waste.

In addition to the manufacture of alcohol from wood waste and from sulphite liquor waste, the Committee has been asked to consider several other methods of obtaining alcohol, but none of these gave promise of being economically feasible.

5. *The Industrial Alcohol Problems.*—That ethyl alcohol can be made from wood waste and sulphite liquor economically in Canada may be considered as established.

Manufacturers are hesitating about putting capital into these developments owing to the uncertainty of the market for alcohol after the war.

The normal consumption of industrial alcohol would be more than satisfied by the production from two large pulp mills.

It is to be hoped that industries will develop to utilize industrial alcohol and that the Government will encourage them by supplying ethyl alcohol "duty free," but under control, to the larger chemical manufacturers.

At a meeting of the Chemistry Committee and representatives of the chemical industries in Canada to be held in May this problem of the utilization of industrial ethyl alcohol will be considered and recommendations thereon made to the Government.

6. *The Utilization of Scrap Leather.*—Owing to the dislocation of trade, resulting from the war, the market for leather waste of various kinds was seriously disturbed, and the Chemistry Committee made a careful investigation of the possible market for this material.

It was found that there were upwards of 2,000 tons a year of waste leather, for which there was a comparatively small market, but since the beginning of the investigation there have been works established in Canada for utilizing the more valuable varieties of waste leather, and as soon as the available raw material reaches a quantity of 5 tons daily, the Committee has been assured that a chemical plant will be established for digesting this leather and converting it into a valuable fertilizer. The

industry is now organizing with a view of securing enough raw material to justify the further development of their plan. They are at present able to take care of all scrap leather which can be pulped and made into leather board.

7. *Toluene from Sulphite Liquor.*—Dr. Bates and Mr. Keay have investigated the possibility of the manufacture of toluene from sulphite turpentine in Canada.

Crude turpentine contains about 90 per cent. cymene; one gallon of the latter yields 0·45 gallon of toluene. Removing the turpentine increases the value of the pulp.

The cymene from half the pulp produced in Canada would give 101,250 gallons of toluene, which would yield 1,470,000 pounds of tri-nitro-toluene.

It has been suggested that the conversion of cymene to toluene be carried out by the Imperial Munitions Board at Trenton. The cost of conversion is small, and it is estimated that the Imperial Munitions Board would save over $50,000 on the 100,000 gallons of toluene produced.

SPECIAL ENQUIRIES.

The Chemistry Committee, through its Chairman, has received a large number of enquiries regarding chemical matters, and others have been referred to it from the various departments of the Government. Many of these required a special search into chemical literature and several involved extensive correspondence, but upwards of one hundred inquiries have received replies. Below is a list of most of the questions submitted during the past year. This will give an idea of the diversity of subjects enquired about:—

Uses for infusorial earth,
Alcohol from wood waste,
Radioactivity of waters of British Columbia,
Synthesis of ethyl alcohol by electric discharge,
Dehydration of fruits and vegetables,
Manufacture of potash from kelp,
Inquiries from British Columbia,
Designing a lime kiln for wood fuel,
Nitrocellulose from pulp,
Cyanide in Canada,
Hydrogenation of fish oils,
Fluorspar in phosphate slag,
Gasolene from natural gas,
Disposal of garbage,
Cottrell process for potash recovery,
Value of eelgrass as fertilizer,
Manufacture of adhesives from sulphite liquor,
Vanadium from titaniferous iron ore,
Calcium chloride in Canada,
Chemical standards for steel,
Manufacture of potato starch,
Methyl chloride from natural gas,
Composition of humus,
Manufacture of potato flour,
Utilization of malt,
Ethyl alcohol from waste materials,
Propylene gas from cracked oils,
Alcohol from potatoes,
Most efficient sewage filter,
Utilization of corn broom waste,
Manufacture of acetone,
Sewall gas generator,
Tannin in pulp-wood bark,
A glue that will withstand alcohol,
Ammonia in peat,
Briquettes from straw,
Lampblack from natural gas,
Value of methyl-ethyl-ketone,
Effect of retting flax on the water of streams,
Manufacture of rare chemicals,
Manufacture of toluene from benzene,
Value of slag as fertilizer,
Manufacture of dimethyl aniline and diphenylamine,
Manufacture of sodium bichromate,
Glue for book binding,
Value of potato dextrin,
Possible chemicals from wood waste,
Use of waste materials in canning apples,
Yeast food for human consumption,
Manufacture of gypsum products,
Uses for magnesium lime,
Value of chemicals in leather tanning,
Relative digestibility of whole wheat and white bread,
Cost of coke ovens,
Manufacture of tin oxide,
Value of nitre cake and uses,
Grauel's process for potash from feldspar,
Aluminium from clay,
Alcohol from wood waste,
Ammonium salts in Canada,
Manufacture of paraldehyde,
Carbon tetrachloride as fire extinguisher,
Ferrosilicon from white quartzite,
Value of Western natural gas for gasolene,
Alcohol from sulphite liquor,
Recovery of tin from tin plate,
Utilization of waste lumber,
Electrical distillation of wood,
Distillation of sawdust before burning,
Enamelling of cement,
Value of "Oakoal" as fuel,
Manufacture of sulphuric acid,
Using iron as a catalyst,
Manufacture of and value of wheat starch,
Potash from feldspar using hydrofluoric acid,
Potash from molasses waste,
Dextrin for bound papers,
Manufacture of rice starch,
Value of small units for wood distillation,
Process patents in Canada,
Acid-resisting varnishes,
Drying potatoes,
Platinum in Canada.

APPENDIX B.

LIST OF STUDENTS AND FELLOWS.

FELLOWSHIPS.

Name.	Where Held.	Subject of Research.
O. J. Walker.....	Chemical Laboratory, University of Saskatchewan.	Products of destructive distillation of straw and their properties. Value and use of the carbon residue as fertilizer and as fuel.
Geo. H. Henderson.....	Physics Department, McGill University.	Thermal conductivity of gases at different temperatures.
W. F. Seyer.....	Chemical Laboratory, University of Alberta.	Constituents of the bitumen of the tar sands of Northern Alberta.

STUDENTSHIPS.

Name.	Where Held.	Subject of Research.
W. H. Hatcher.....	Chemical Laboratory, McGill University.	Study of the halogen and hydroxy derivatives of acetylene.
R. J. Clark.....	Physics Department, McGill University.	Investigation of the coefficient of viscosity of different gases at various temperatures.
O. J. Bridgeman.....	Chemical Laboratory, University of Saskatchewan.	The thermosynthesis of higher hydrocarbons from natural gas.
Richard Hamer.....	Physics Department, University of Toronto.	Research on rubber colloids.
H. J. C. Ireton.....	Physics Department, University of Toronto	*Short wave length radiation and its relation to atomic structure.
J. F. T. Young.....	Physics Department, University of Toronto.	*Short wave length phenomena and their relation to atomic structure.

*Work was not commenced, as both of these students enlisted in the Canadian Naval Service immediately after Studentships were awarded.

APPENDIX C.

GENERAL REGULATIONS COVERING THE AWARD FOR 1918 OF THE STUDENTSHIPS AND FELLOWSHIPS.

A.—Regulations Governing Studentships.

1. These studentships are intended, not to facilitate attendance on ordinary collegiate studies, but to enable students, who have passed through a college curriculum and have given distinct evidence of capacity for original research, to continue the prosecution of science with the view to aiding its advance or its application to the industries of the country. These studentships are open to men and women.

2. The studentships are each of the value of $750 for each year of tenure. The continuation of the studentship for a second year is dependent on the work done in the first year being satisfactory to the Advisory Council.

3. Application for a studentship must be made by the candidate to the Advisory Council. He shall, with his application, submit a complete record of his academic career and recommendations from the President of his University or Institution, the Head of the department with which he was connected, and the Professor or Instructor under whom he worked. He shall state the institution at which he prefers to study, and the general line of work to be followed. The application will be considered and decided upon by the Advisory Council or by a special committee appointed by the same.

4. The candidates must be British subjects, resident in Canada or graduates of Canadian Universities, and must be between the ages of twenty and thirty-two years.

5. A candidate must (1) be a bona fide graduate of a University or College in which special attention is given to scientific study, or (2) have received an equivalent training in an institution possessing adequate facilities of a scientific character for providing such training.

6. The departments of science in which capacity for research will be accepted as qualifying for a studentship are: biology (economic), chemistry, engineering, geology, metallurgy, mineralogy, and physics.

7. The candidate must indicate high promise of capacity for advancing science or its application by original research. Evidence of this capacity is strictly required, this being the main qualification for a studentship. The most suitable evidence is a satisfactory account of a research already performed.

8. Studentships may be held at any Canadian University or Institution approved by the Advisory Council during the first year, but the research may, during the second year, be carried on in some scientific laboratory or works.

9. The principal work of the holder of a studentship must be a research in some branch of science, the extension of which is important to the national industries.

10. Students are required to devote themselves for a period of at least nine months of each year wholly to the objects of the studentships, and are forbidden to hold any position of emolument or to engage in teaching.

11. Students are required to furnish reports of their work at the end of each half year of the tenure of their studentships. At the expiration of each year of studentship the reports of the student are referred to an authority on the subject treated, who furnishes an opinion thereon to the Advisory Council.

12. The studentship stipend is payable in two equal instalments, on September 15 and February 1.

B.—Regulation Regarding Research Fellowships.

1. The research fellowships are of the value of $1,000 for the first year, and of $1,200 for the second year if the Advisory Council should decide to extend the fellowship over two years.

2. Fellowships are only awarded to those who, either through previous tenure of a studentship, or otherwise, have shown a high capacity for research on some problem the extension of which is of importance to the national industries of Canada.

3. Applications for fellowships should be made in a manner similar to those for studentships.

APPENDIX D.

REGULATIONS GOVERNING THE AWARD OF GRANTS FOR RESEARCH.

1. The recommending of the giving or refusing of grants by the Advisory Council shall be in the hands of a Committee of three members of the Council to be known as the Committee on Assisted Researches. This Committee may utilize the advice and assistance of any persons inside or outside the Council who, in their judgment, may be of value in any application under consideration.

2. The applicant must give a brief statement of the proposed investigation, its scope, time required, results hoped for, total cost, grant asked, specific purpose to which grant applied for is to be put, evidence of ability to carry on the investigation, concise statement of adequacy of general equipment of laboratory where investigation is to be carried on. If the applicant has asked for or is receiving a grant from any other body, he must state this fact in his application.

3. Grants will, as a general rule, only be made to persons who are conducting investigations in established laboratories which possess the fundamental apparatus and facilities necessary for research of the nature proposed, and where the ordinary overhead charges are already provided for, and will not be made for the purchase of standard apparatus which a well-equipped laboratory should possess.

4. Grants made are to be for requirements for one year only, but further grants may be made annually.

5. Grants will be made only to persons who can show capacity for independent research, and who have a reputation for trustworthiness and responsibility.

6. Grants are to be made only for the actual expenses of investigation, but may be used in whole or in part for the payment of assistants, and are not intended to support the grantee while carrying out the investigation.

7. When a grant has been made for a specific purpose, it must be used for that purpose only. If the grantee desires to change in any manner the subject of his investigation he must make application to have the grant made available for the altered investigation.

8. All apparatus and materials purchased with grants are to be regarded as the property of the Advisory Council, and when the investigation is concluded are to be subject to the disposition of the Council.

9. A report of progress is to be made annually by the grantee, or whenever called for, and, in every case, on the completion or conclusion of the investigation.

10. The grantee shall render annually, or whenever called upon, an itemized account of his expenditure, with vouchers. Such account shall also be made on the completion or conclusion of the investigation, and the balance of the grant required shall be paid over to the Advisory Council.

11. The grantee shall present a complete copy of the results of his investigation. before its publication, to the Advisory Council, who shall have the right of publishing it under their own auspices. When the grantee publishes his research, he shall make due acknowledgment of the assistance received from the Council.

12. The Council will give careful consideration to every application, but will not assign reasons for refusing to make grants applied for.

APPENDIX E.

REPORT OF THE COMMITTEE OF THE PRIVY COUNCIL, APPROVED BY HIS ROYAL HIGHNESS THE GOVERNOR GENERAL ON THE 6TH JUNE, 1916.

The Committee of the Privy Council have before them a report, dated 23rd May, 1916, from the Minister of Trade and Commerce, to whom was referred a despatch from the Right Hon. A. Bonar Law, Secretary of State for the Colonies, calling attention to a scheme of scientific and industrial research for the United Kingdom, as embodied in Parliamentary Paper Cd. 8005, attached hereto, and a copy of the Order in Council approving the same.

The Minister observes that this scheme, proposed by Mr. Arthur Henderson, contemplated the appointment of a Committee of the Privy Council which should be responsible for the carrying out of the same, and a small Advisory Council resonsible to the Committee to be composed mainly of scientific men and men actually engaged in industries dependent upon scientific research. By Order in Council, 28th July, 1915, effect was given this scheme, and the Committee and Council proposed therein were appointed and their respective duties set out. The scheme was to be applied to the United Kingdom as a whole and was not intended in any way to interfere with the arrangements already made by the War Office and the Admiralty in respect to obtaining scientific assistance for the improvement of munitions of war, but was designed to establish a permanent organization for the promotion of scientific and industrial research.

The Minister observes that after this scheme had gone into operation, suggestions were made from various sources that it should be extended and made applicable to the Overseas Dominions or even to the Empire as a whole. These suggestions were approved in principle by the Committee of Council, and a memorandum was prepared intimating certain preliminary steps that might be taken to bring about gradually co-operation of effort and co-ordination of research throughout the Empire.

On the 20th January, 1916, the Minister of Munitions caused to be distributed to educational institutions in the United Kingdom a circular letter inviting co-operation in the improvement and invention of appliances for the prosecution of warfare, and copies of the same were sent to certain universities in Canada. As a result these universities have given full information on the facilities they possess for carrying on research work in respect to the specific purpose of the Minister of Munitions. They express willingness also to co-operate and assist in the work of industrial research, and are of the opinion that some department of the Government of Canada should undertake to co-ordinate and supervise this work and act as a medium of communication.

The Minister desires to point out the urgent necessity of organizing, mobilizing and encouraging the existing resources of industrial and scientific research in Canada with the purpose of utilizing waste products, discovering new processes—mechanical, chemical and metallurgical—and developing into useful adjuncts to industry and commerce the unused natural resources of Canada. At no period has the importance of such united and thorough action been so evident as since the conditions brought about by the war, when the scarcity of certain compounds and processes has caused confusion and paralysis in industries and greatly added to costs of living. Canada has educational and scientific institutions more or less well equipped for conducting this research, which have already done much along their several lines and are willing and anxious to equip themselves for doing more. There are also private, corporate and Government laboratories, more or less engaged in research work. The manufacturers are alive to the importance and absolute necessity of such work in relation to the industries of the country and are anxious to co-operate in and support it.

What seems to be immediately urgent is to have some method of co-ordination and direction which shall combine the efforts of all, along the lines for which each is best adapted and which would tend to avoid duplication and promote efficiency of action. To this end the Minister has been more or less in continuous communication and conference with representatives of the Universities, the Canadian Manufacturers' Association and the scientific institutions. The consideration thus given has resulted in a practically unanimous agreement both as to the necessity of immediate action and as to the lines along which it should be taken.

The Minister, therefore, recommends the appointment of a Committee of Council to consist of the Minister of Trade and Commerce, the Minister of the Interior, the Minister of Mines, the Minister of Inland Revenue, the Minister of Labour, and the Minister of Agriculture, which shall be charged with, and responsible for, the expenditure of any moneys provided by Parliament for scientific and industrial research, and also an Honorary Advisory Committee, responsible to the Committee of Council, to be composed of nine members, representative of the scientific and industrial interests of Canada, who shall be charged with the following duties:—

(*a*) To consult with all responsible bodies and persons carrying on scientific and industrial research work in Canada with a view to bringing about united effort and mutual co-operation in solving the various problems and industrial research which from time to time present themselves;

(*b*) To co-ordinate as far as possible the work so carried on so as to avoid overlapping of effort, and to direct the various problems requiring solution into the hands of those whose equipment and ability are best adapted thereto;

(*c*) To select the most practical and pressing problems indicated by industrial necessities and present them when approved by the Committee to the research bodies for earliest possible solution;

(*d*) To report from time to time the progress and results of their work to the Minister of Trade and Commerce as Chairman of the Committee of Council.

That a competent Secretary be appointed on the nomination of the Committee and paid by the Department of Trade and Commerce.

That the travelling expenses of the Committee shall be paid by the Department of Trade and Commerce.

The Committee concur in the foregoing and submit the same for approval.

RODOLPHE BOUDREAU,
Clerk of the Privy Council.